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(54) **STACKED FIBER OPTIC MODULES AND FIBER OPTIC EQUIPMENT CONFIGURED TO SUPPORT STACKED FIBER OPTIC MODULES**

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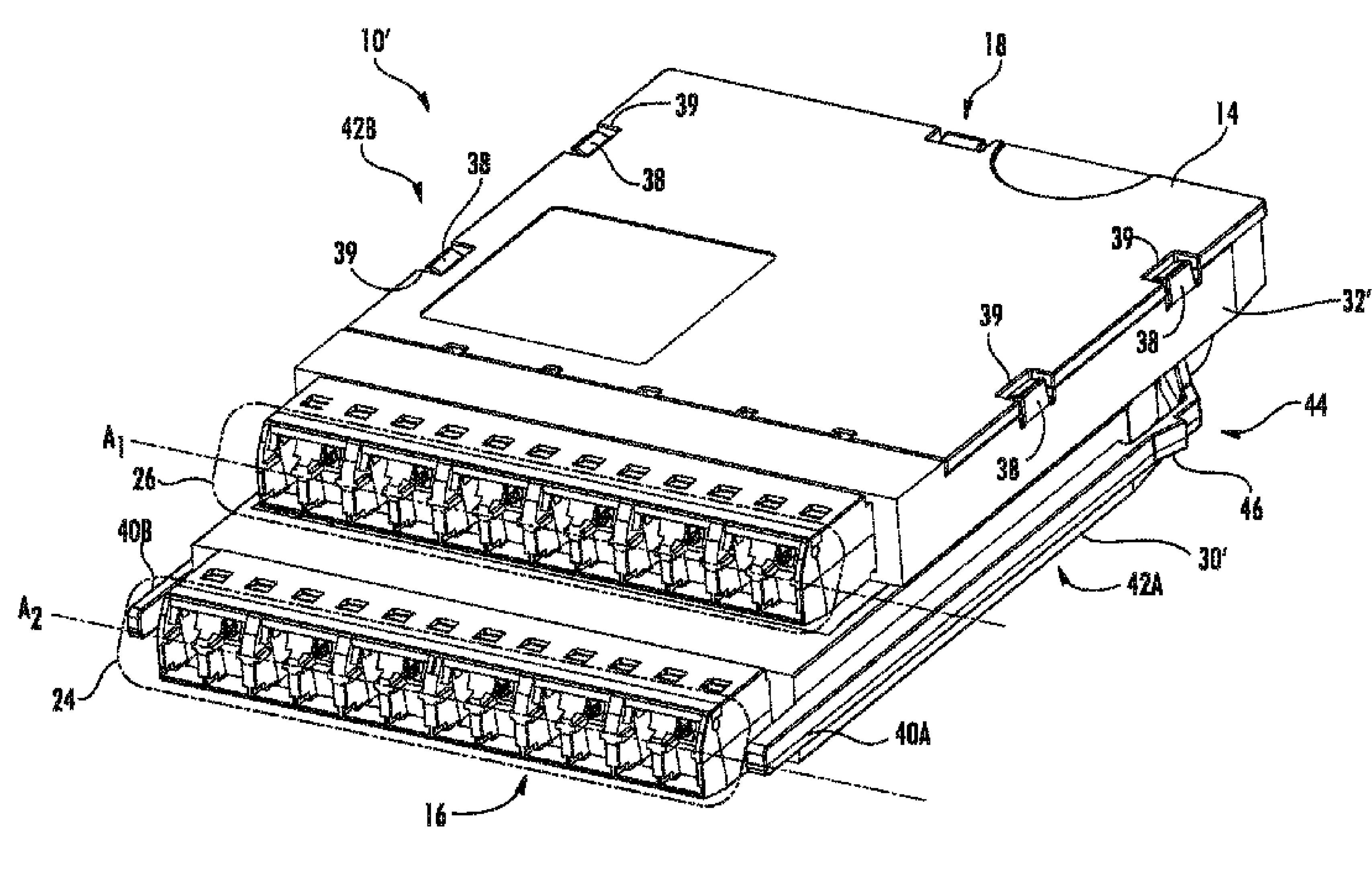
(57) **ABSTRACT**

Embodiments disclosed in the detailed description include stacked fiber optic modules and fiber optic equipment supporting stacked fiber optic modules. In one embodiment, a stacked fiber optic module is provided. This embodiment of the stacked fiber optic module comprises a body having a first sub-body and a second sub-body where the second sub-body can translate relative to the first sub-body. The stacked fiber optic module further comprises a first plurality of fiber optic components disposed in a first longitudinal axis in the at least one front side. The stacked fiber optic module also further comprises a second plurality of fiber optic components disposed adjacent the first plurality of fiber optic components in a second longitudinal axis parallel or substantially parallel to the first longitudinal axis in the at least one front side.

19 Claims, 24 Drawing Sheets



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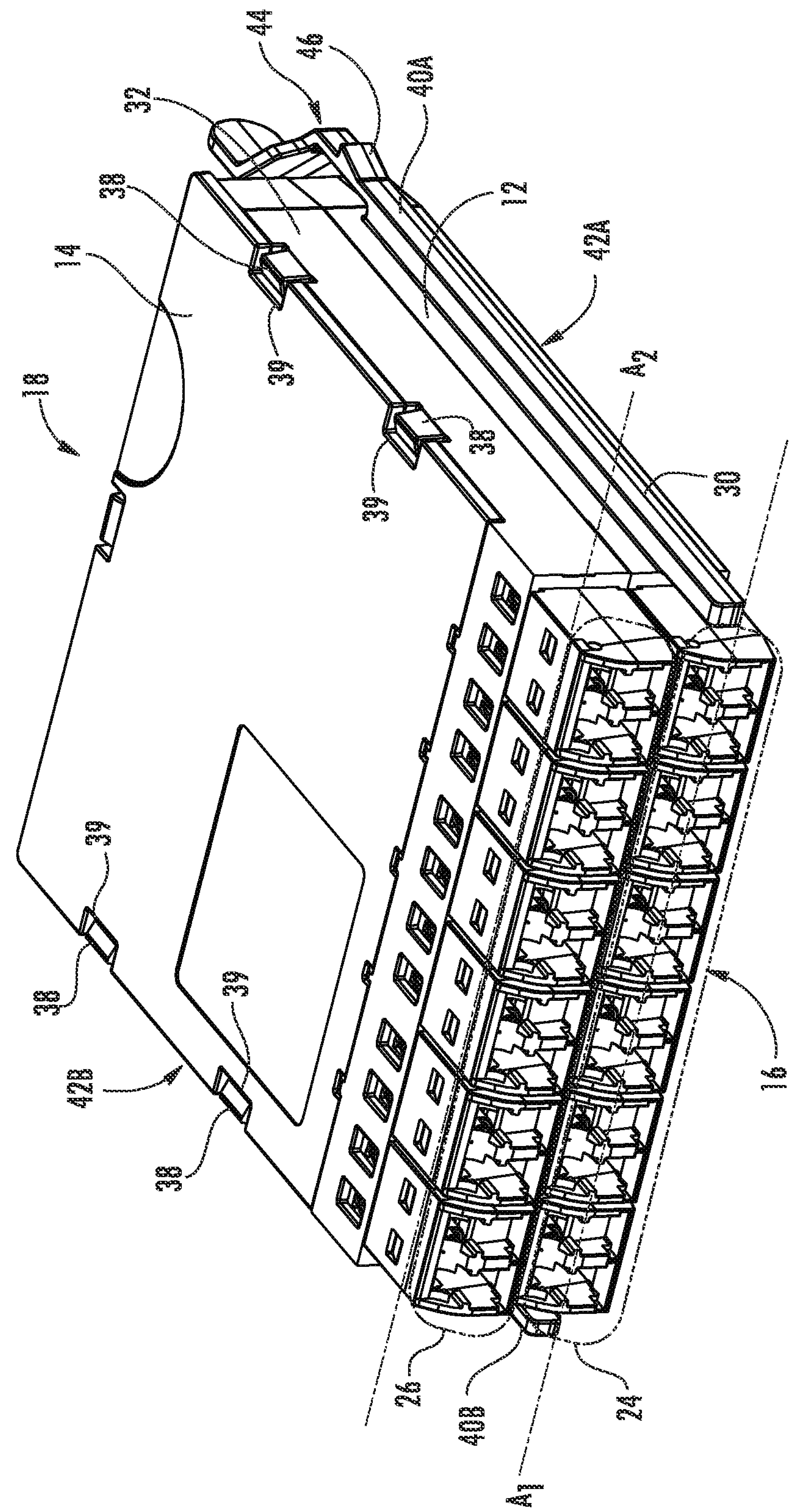
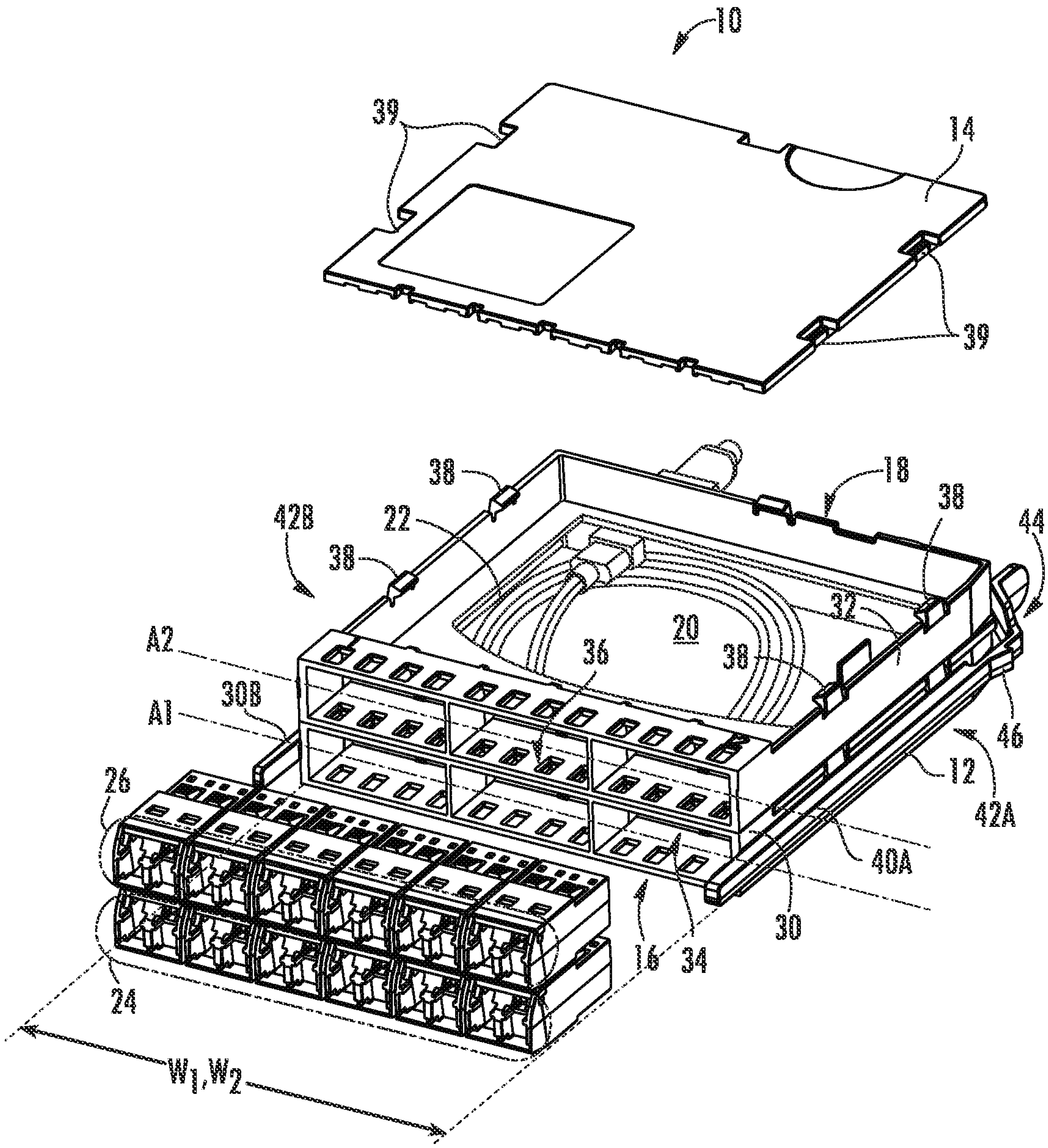


FIG. 1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14
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42B
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44
38
32
20
A2
38
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A1
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12
42A
40A
16
34
30
24
W1,W2

FIG. 2

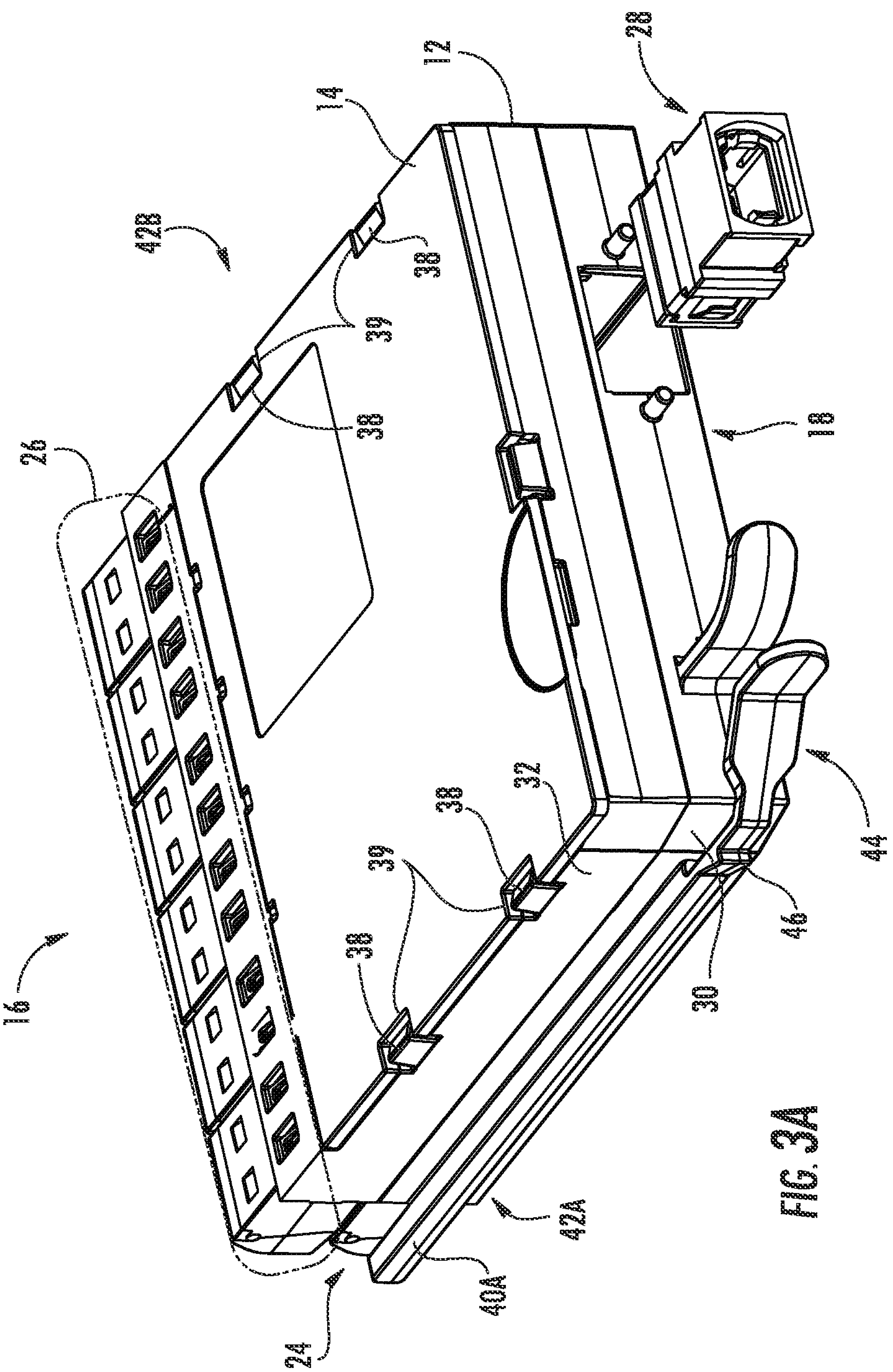


FIG. 3A

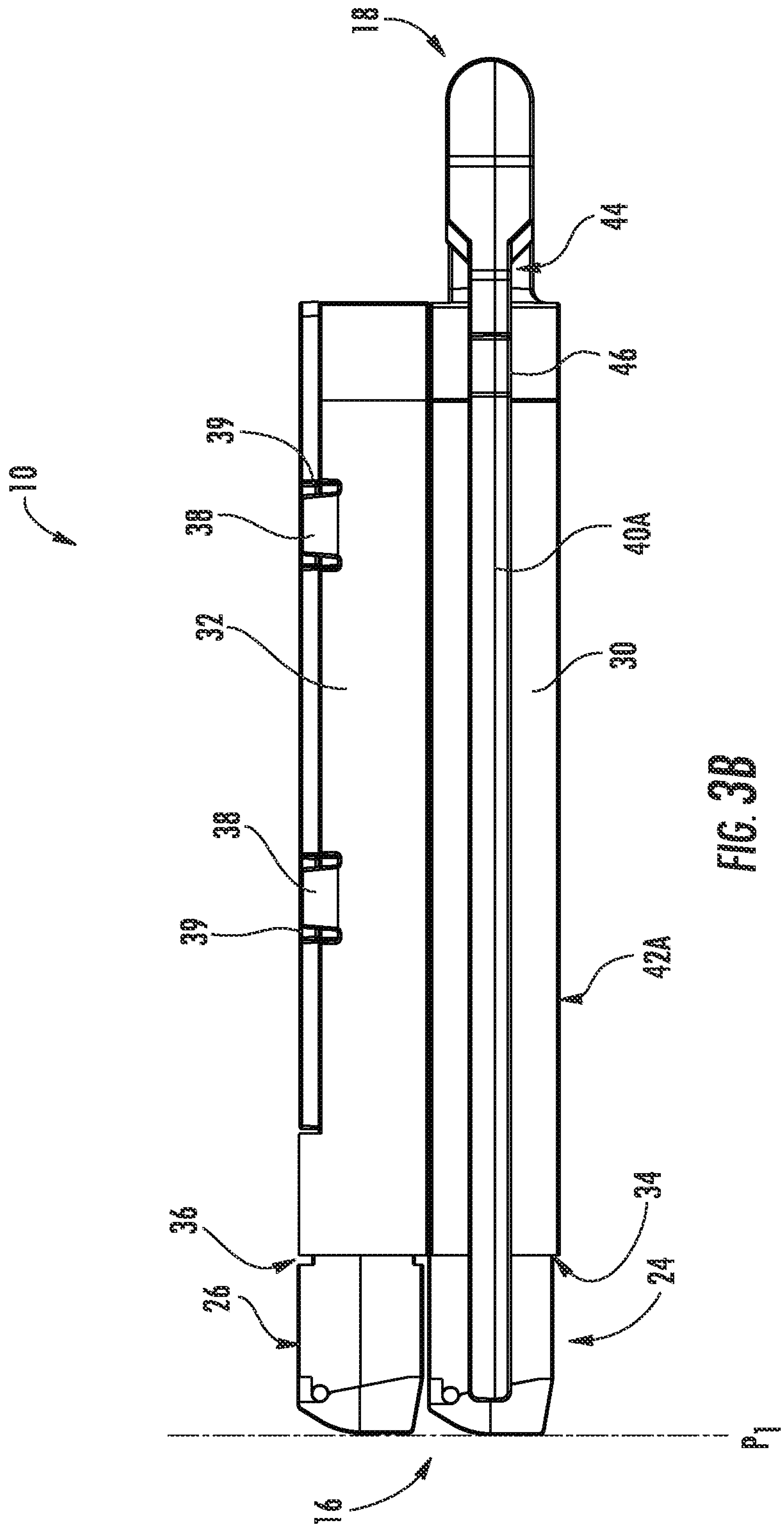


FIG. 3B

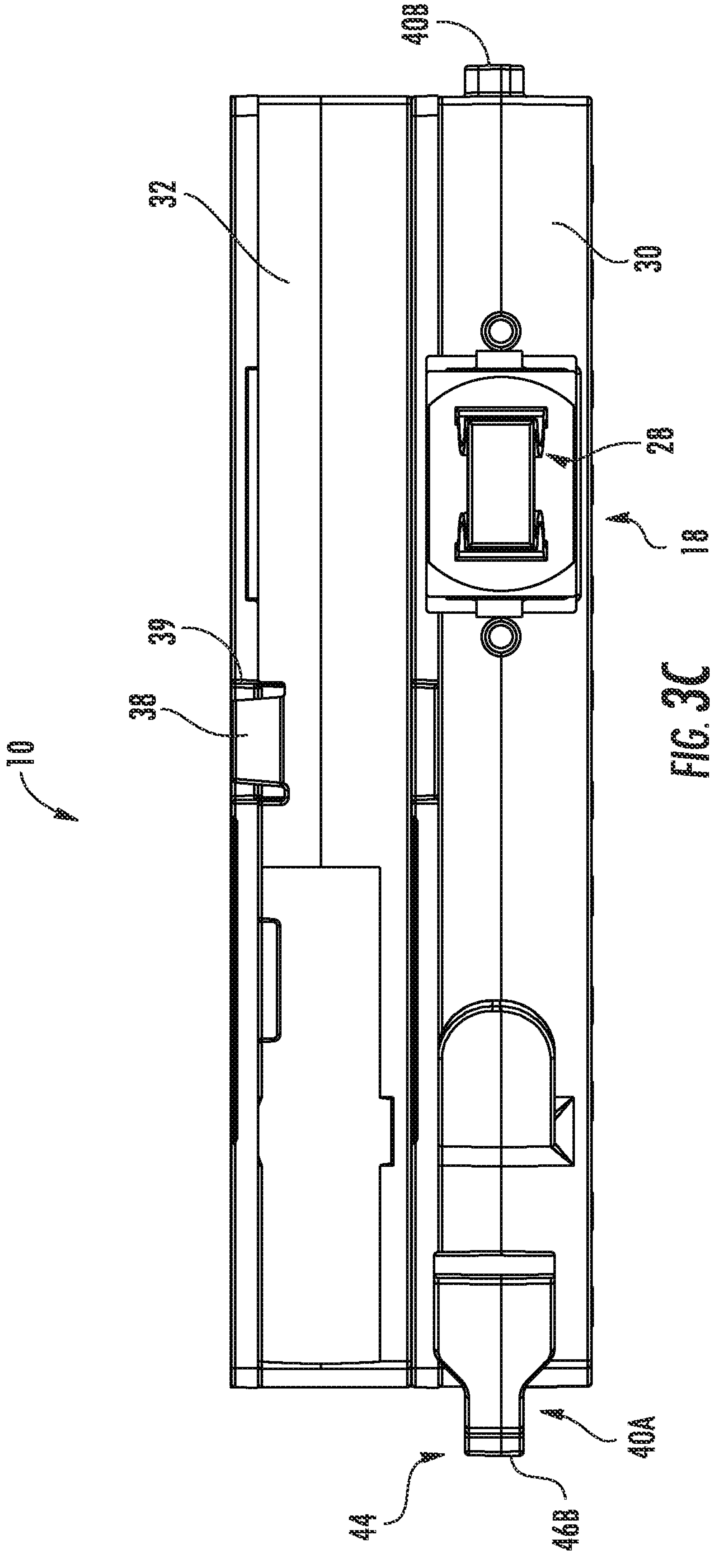
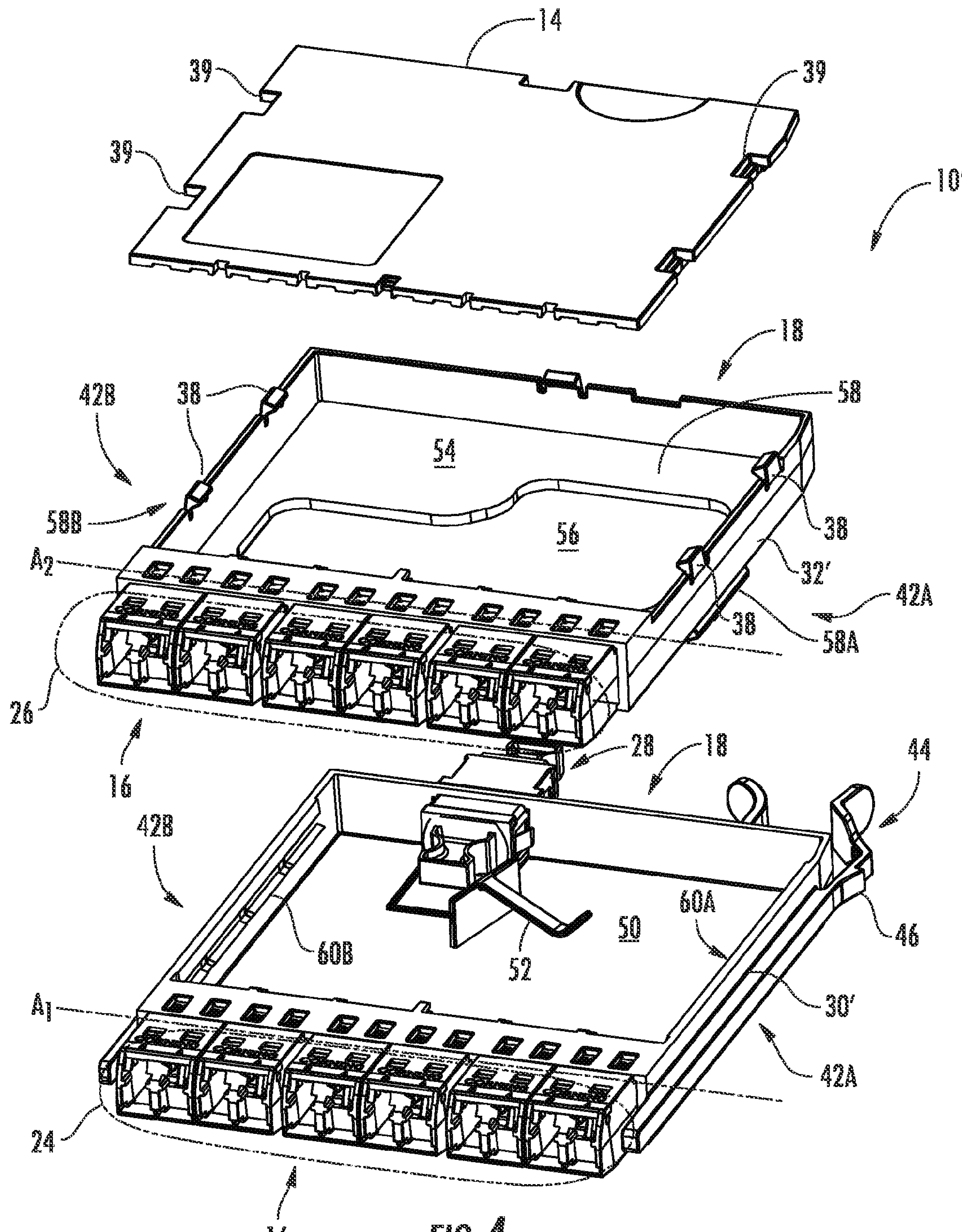


FIG. 3C


14
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10'
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42B
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54
58B
56
38
A2
32'
42A
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58A
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44
42B
60A
50
46
60B
52
A1
30'
42A
24
16

FIG. 4

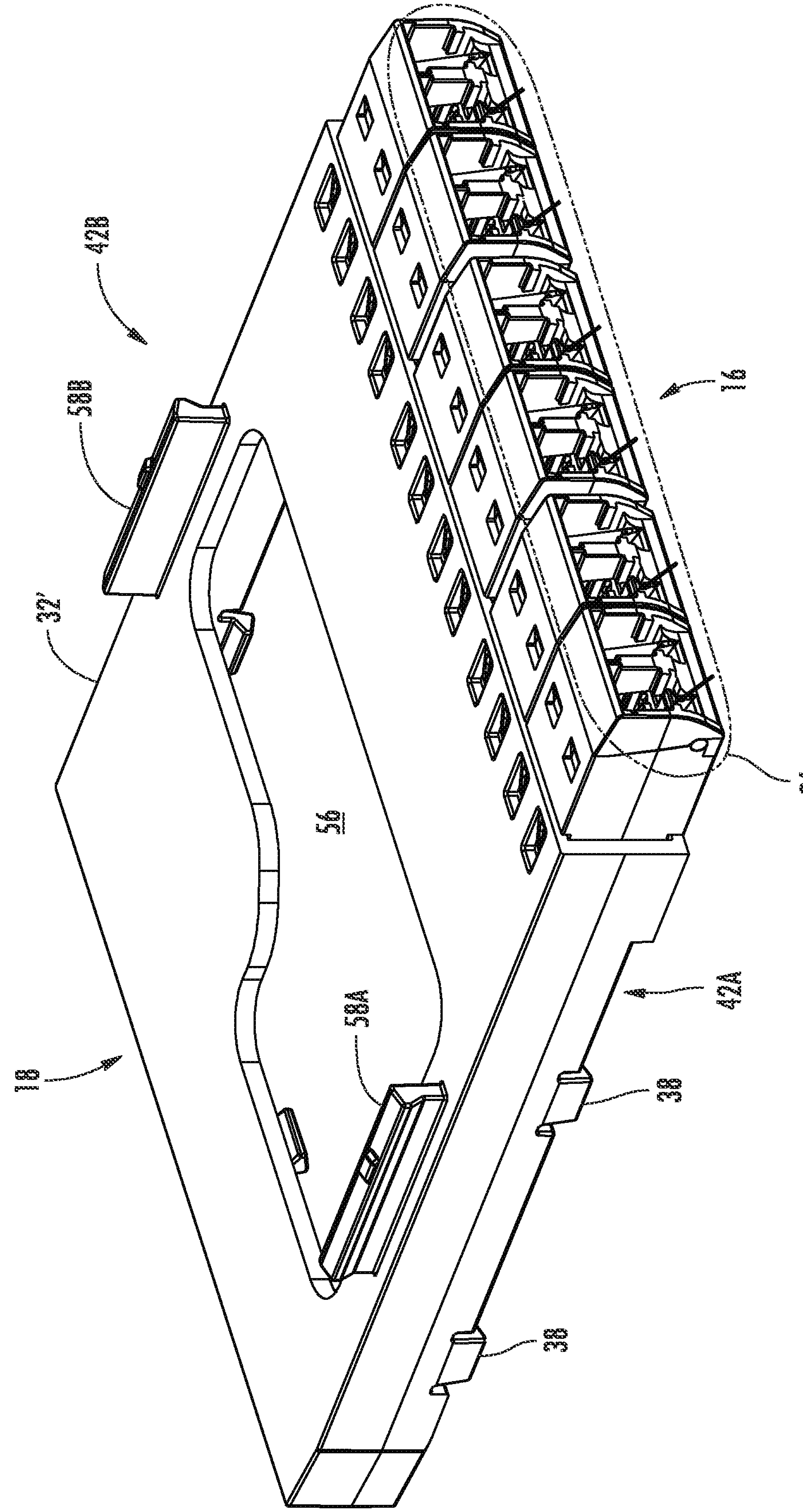

FIG. 5A

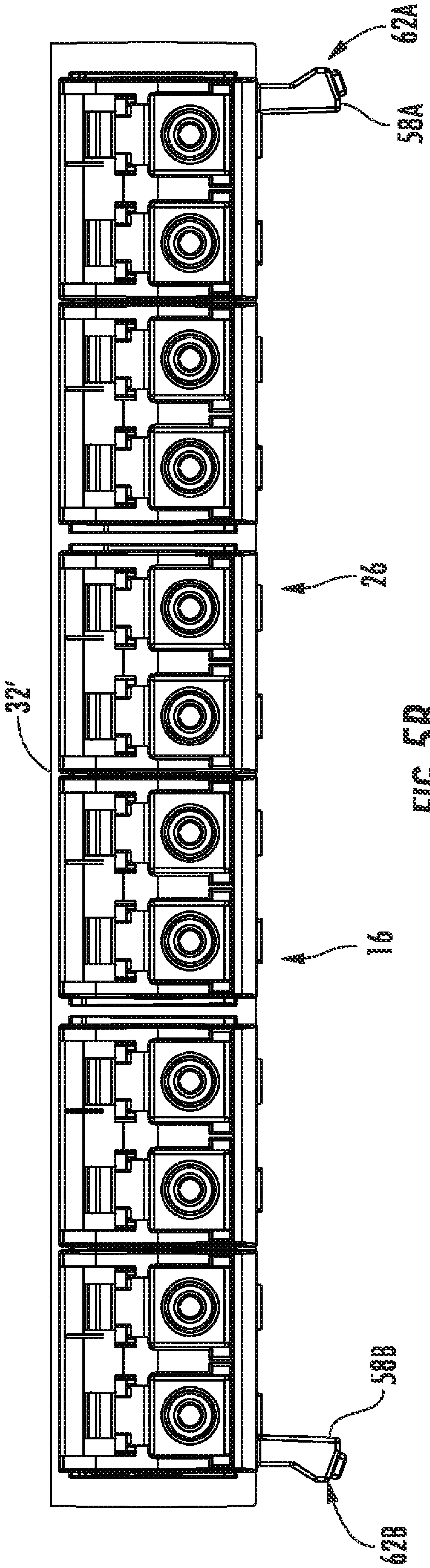

FIG. 5B

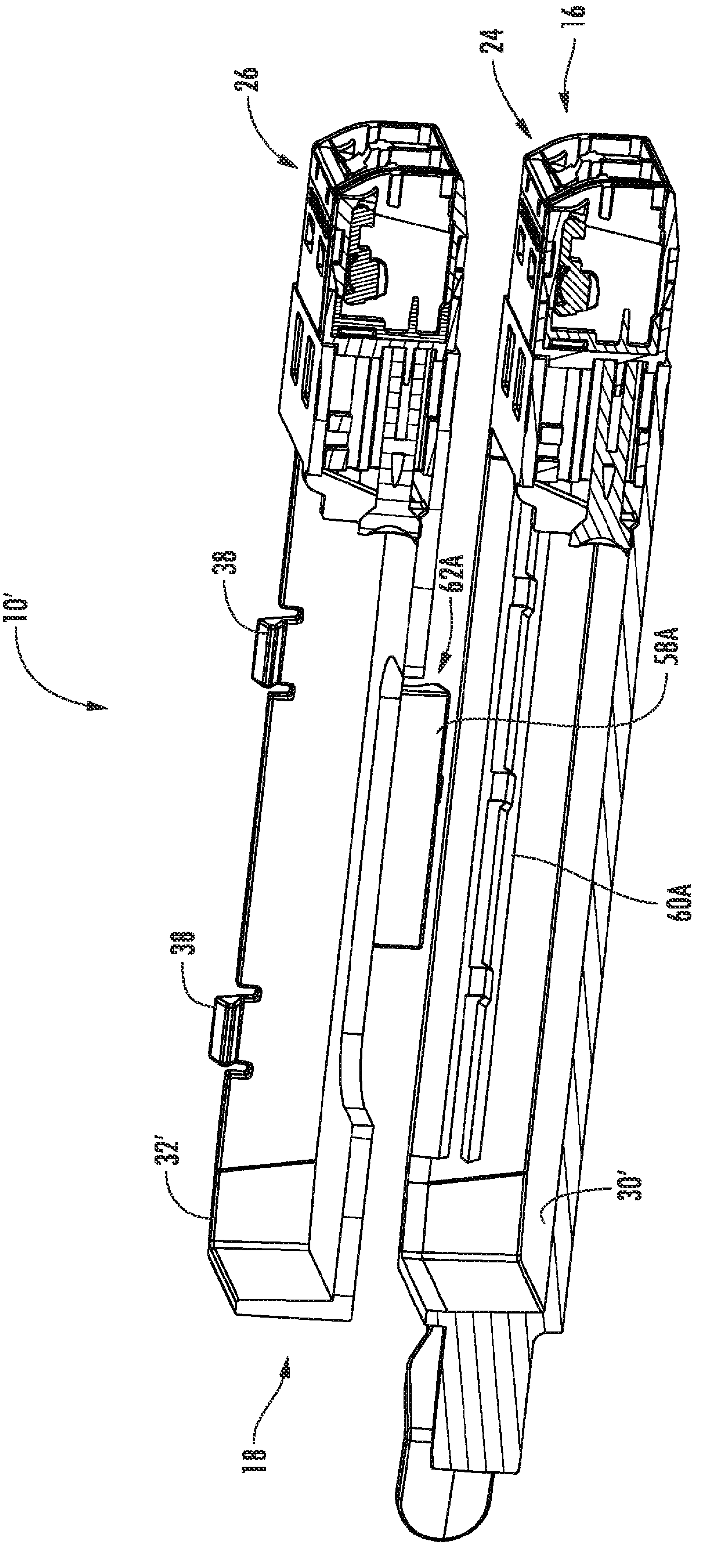

FIG. 6A

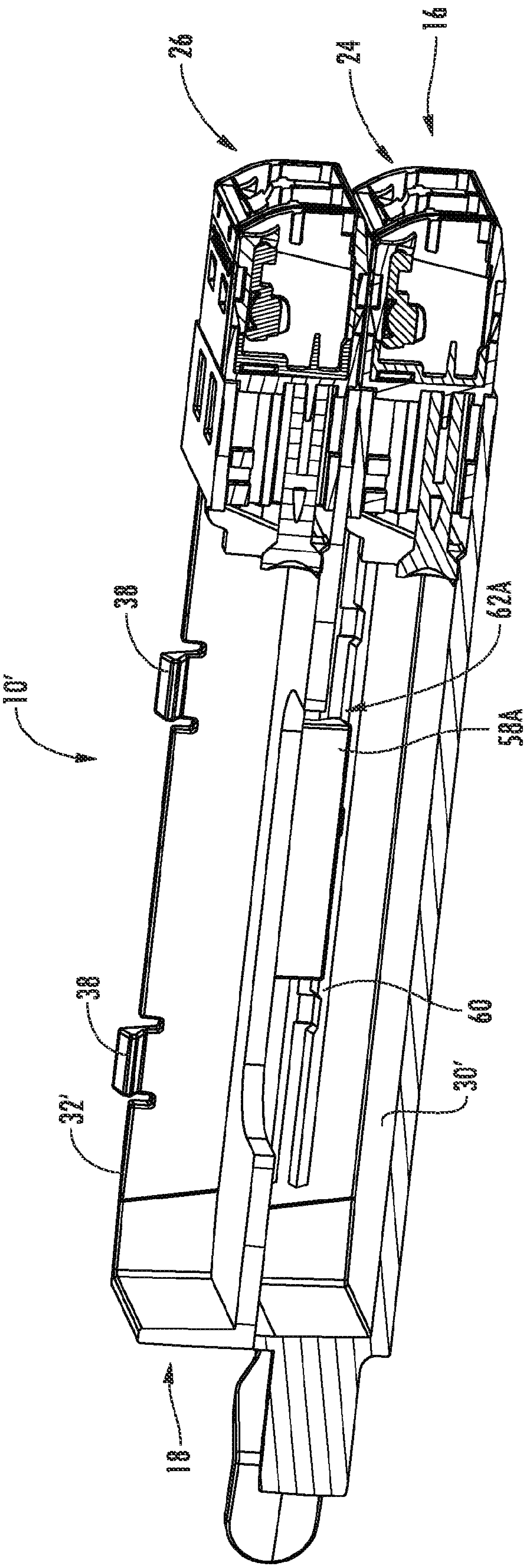

FIG. 6B

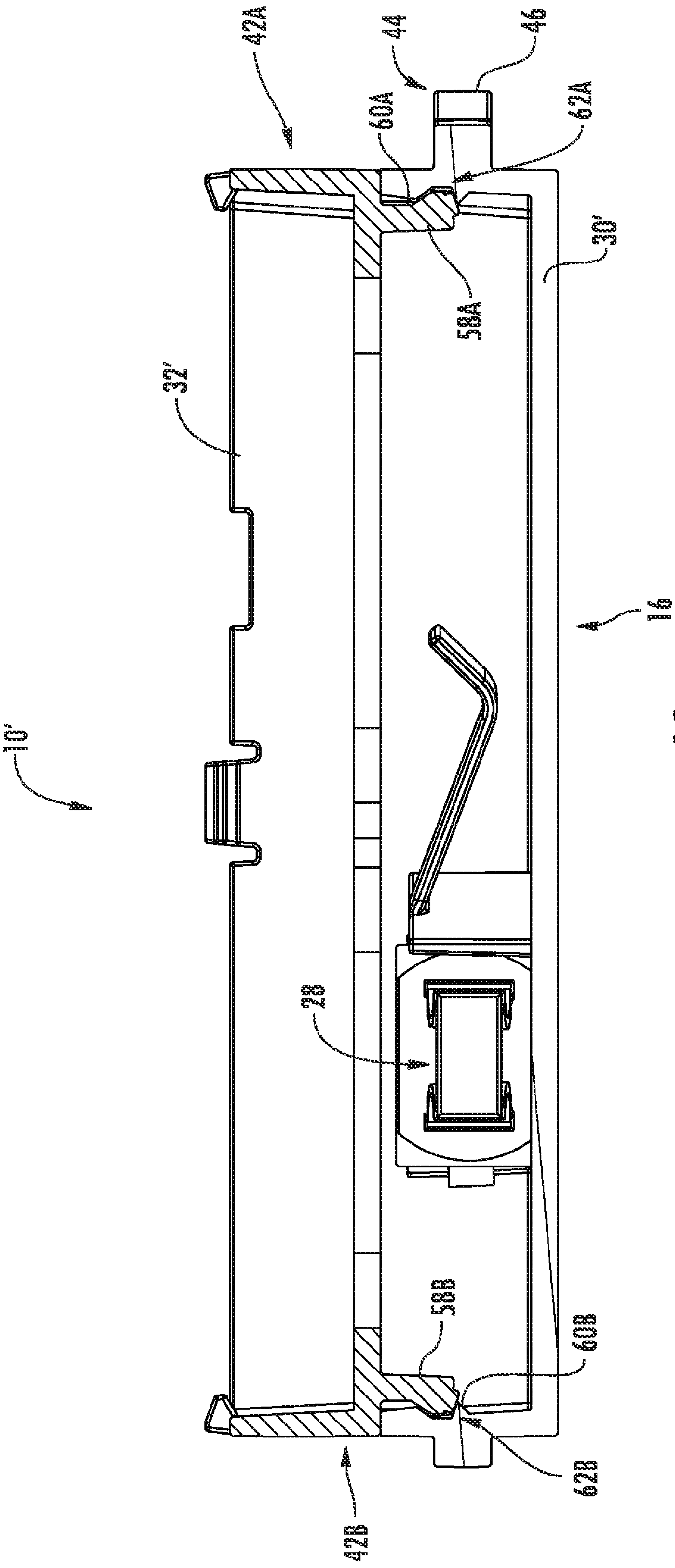

FIG. 6C

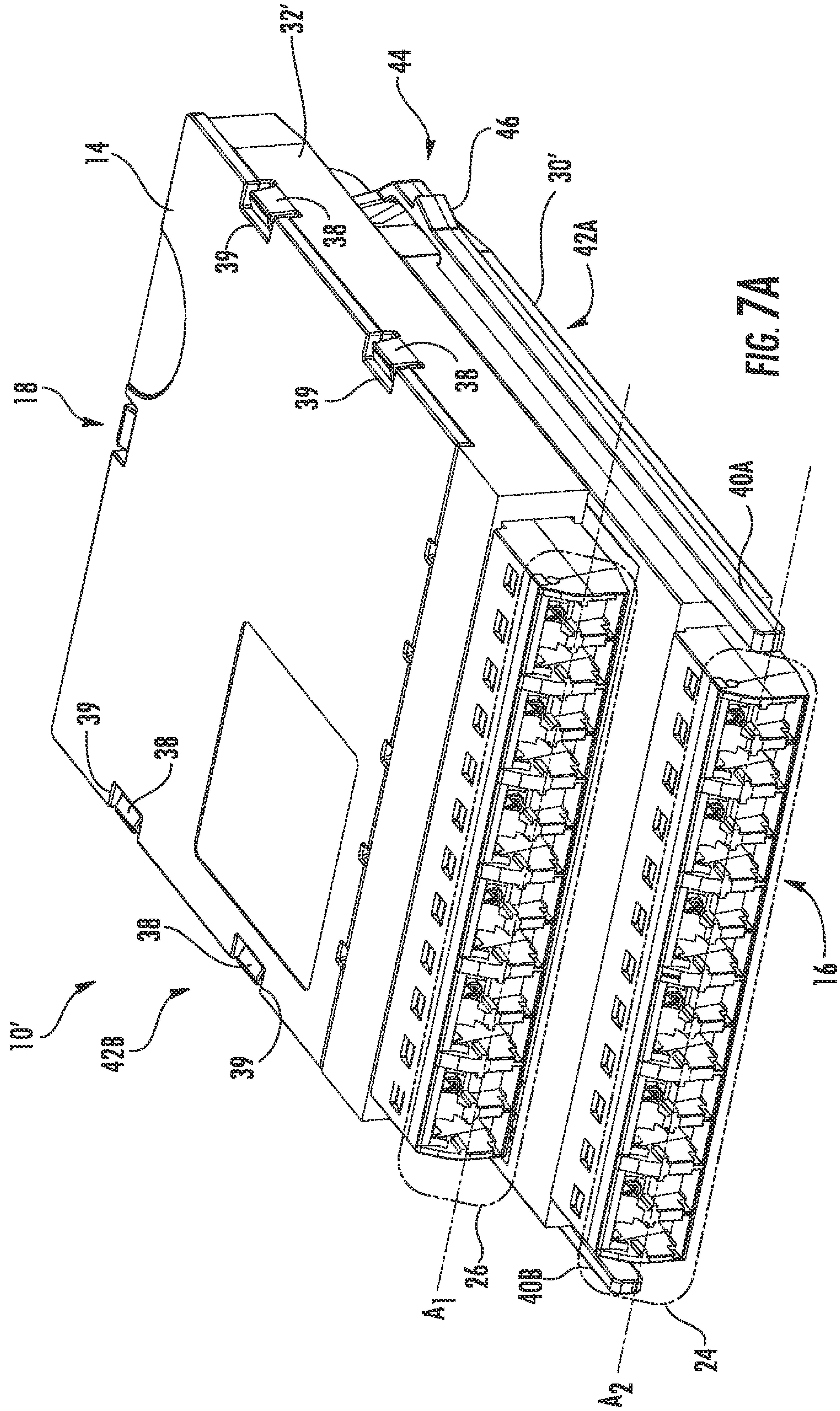

FIG. 7A

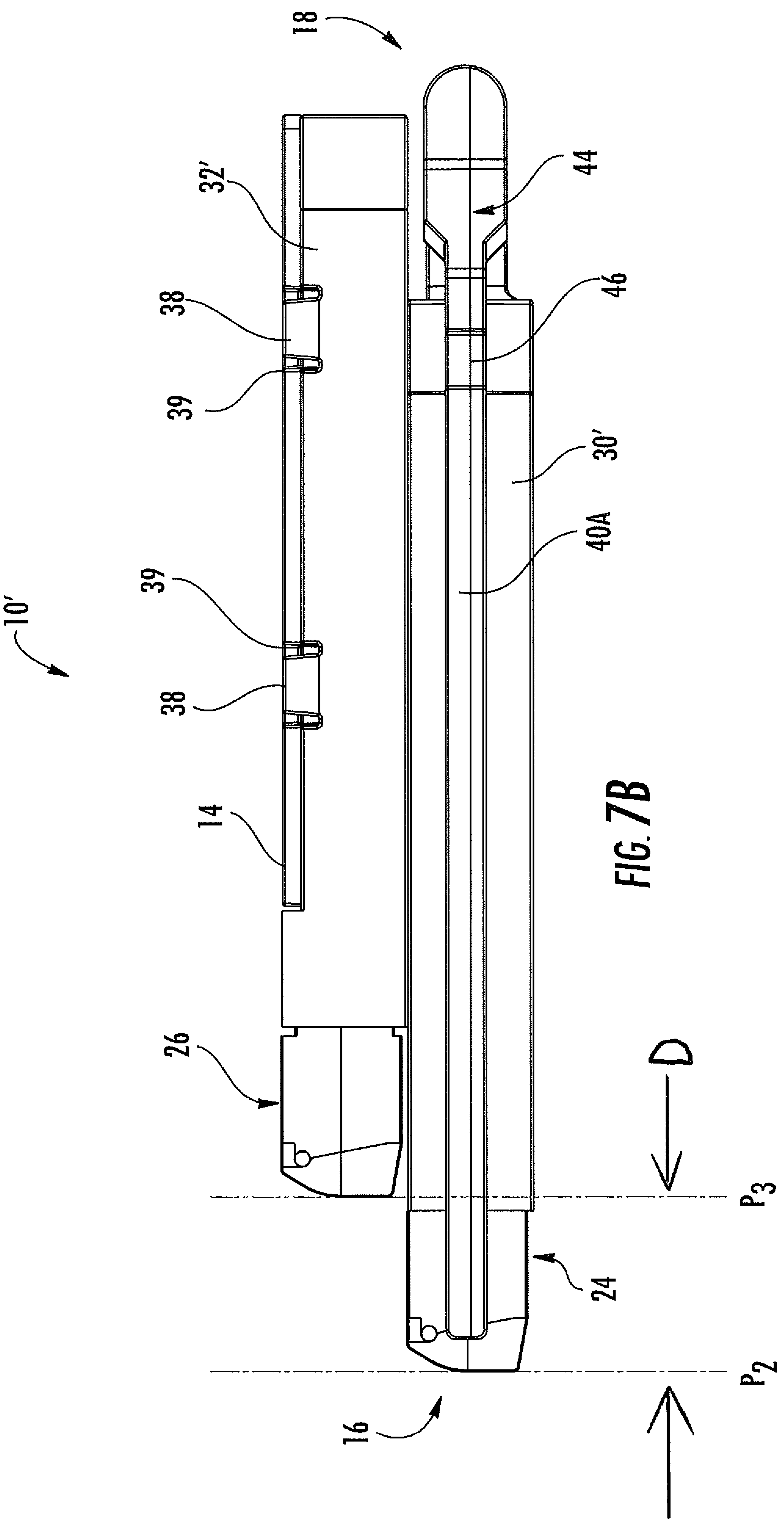

FIG. 7B

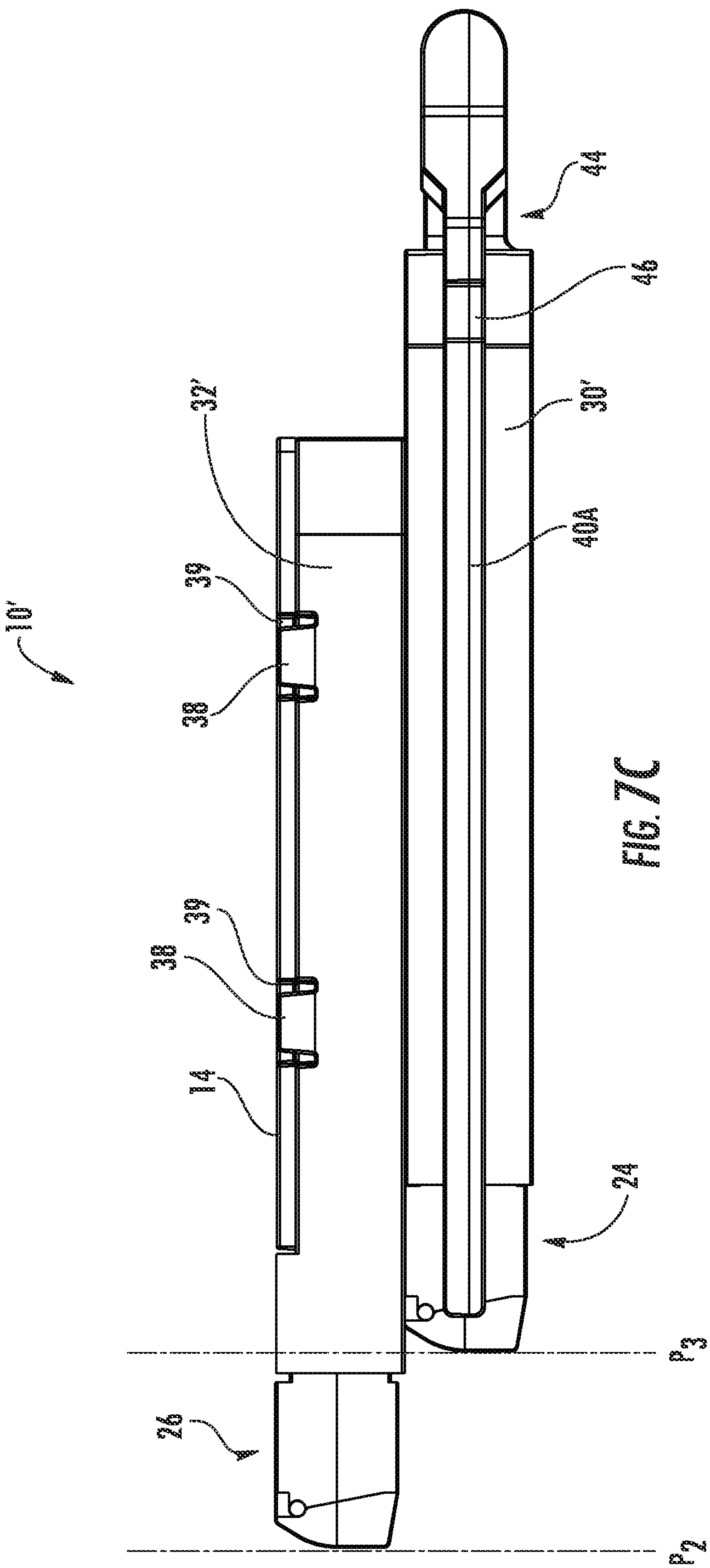

FIG. 7C

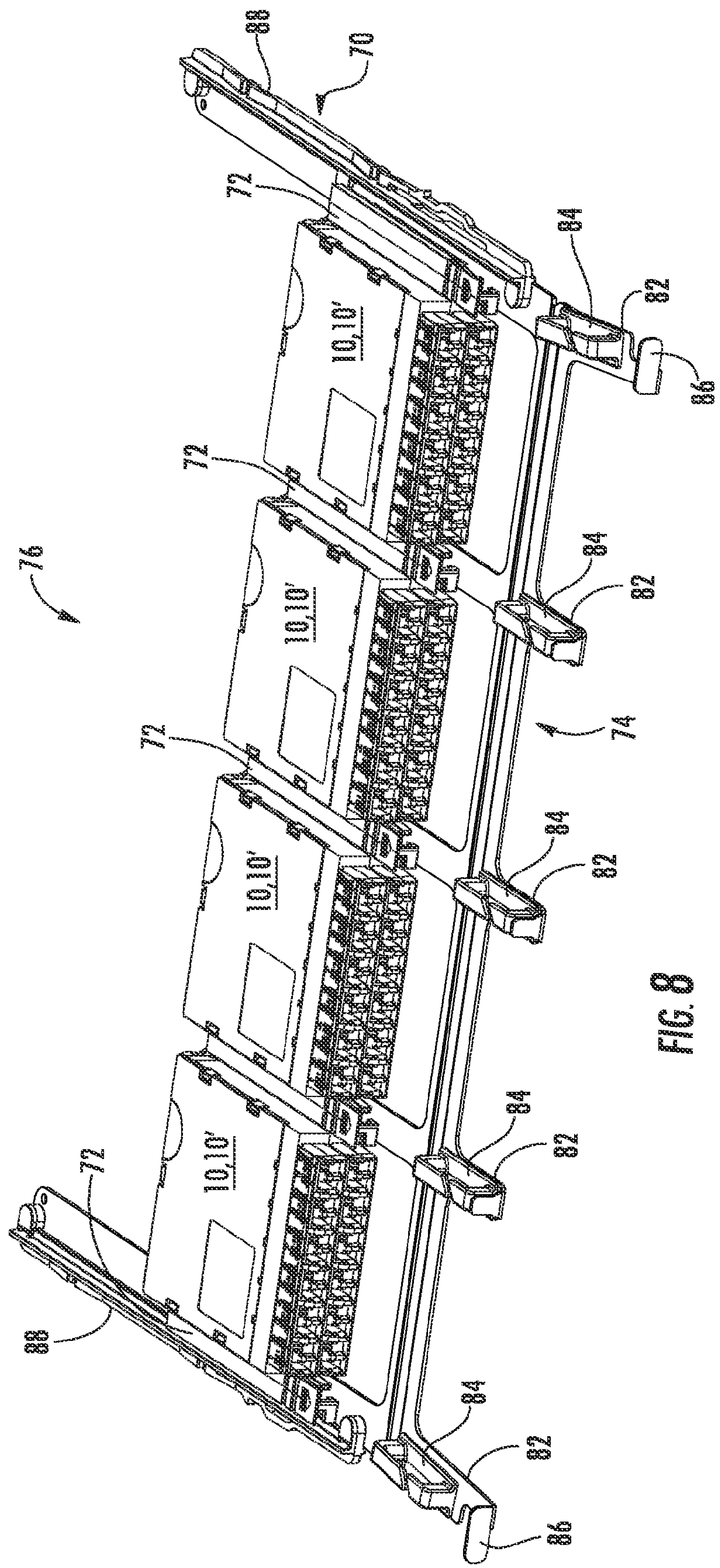

FIG. 8

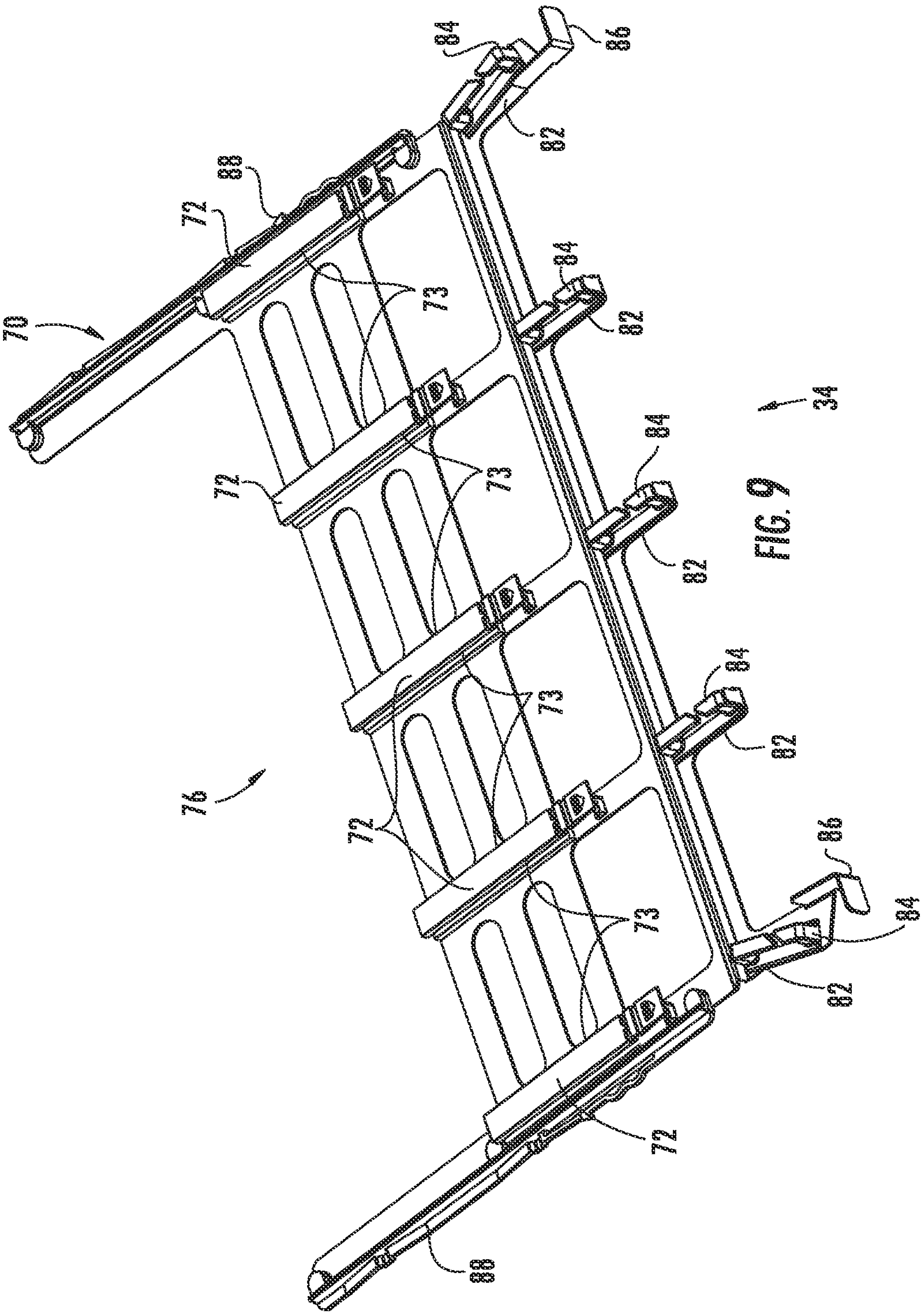
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FIG. 9

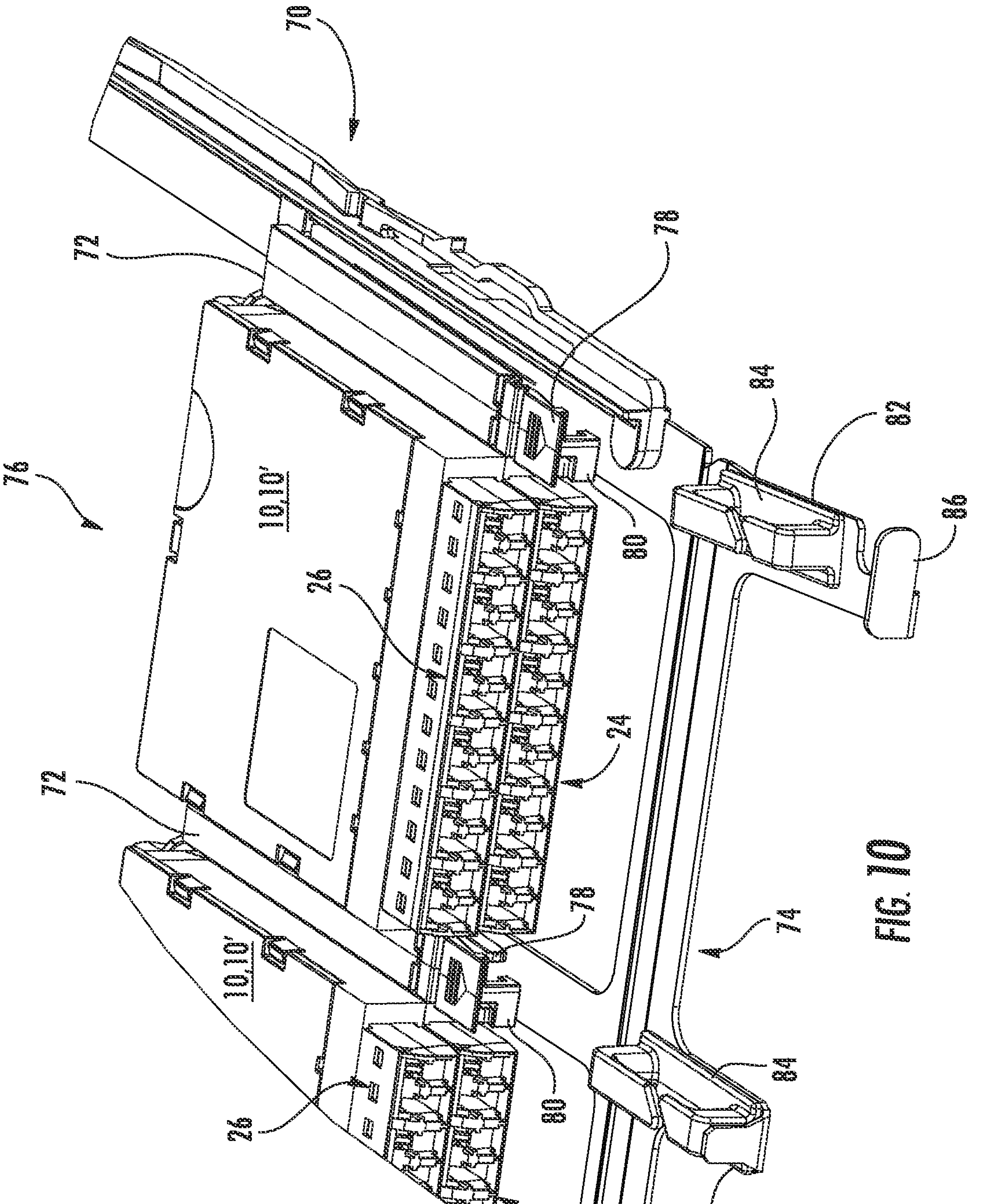

FIG. 10

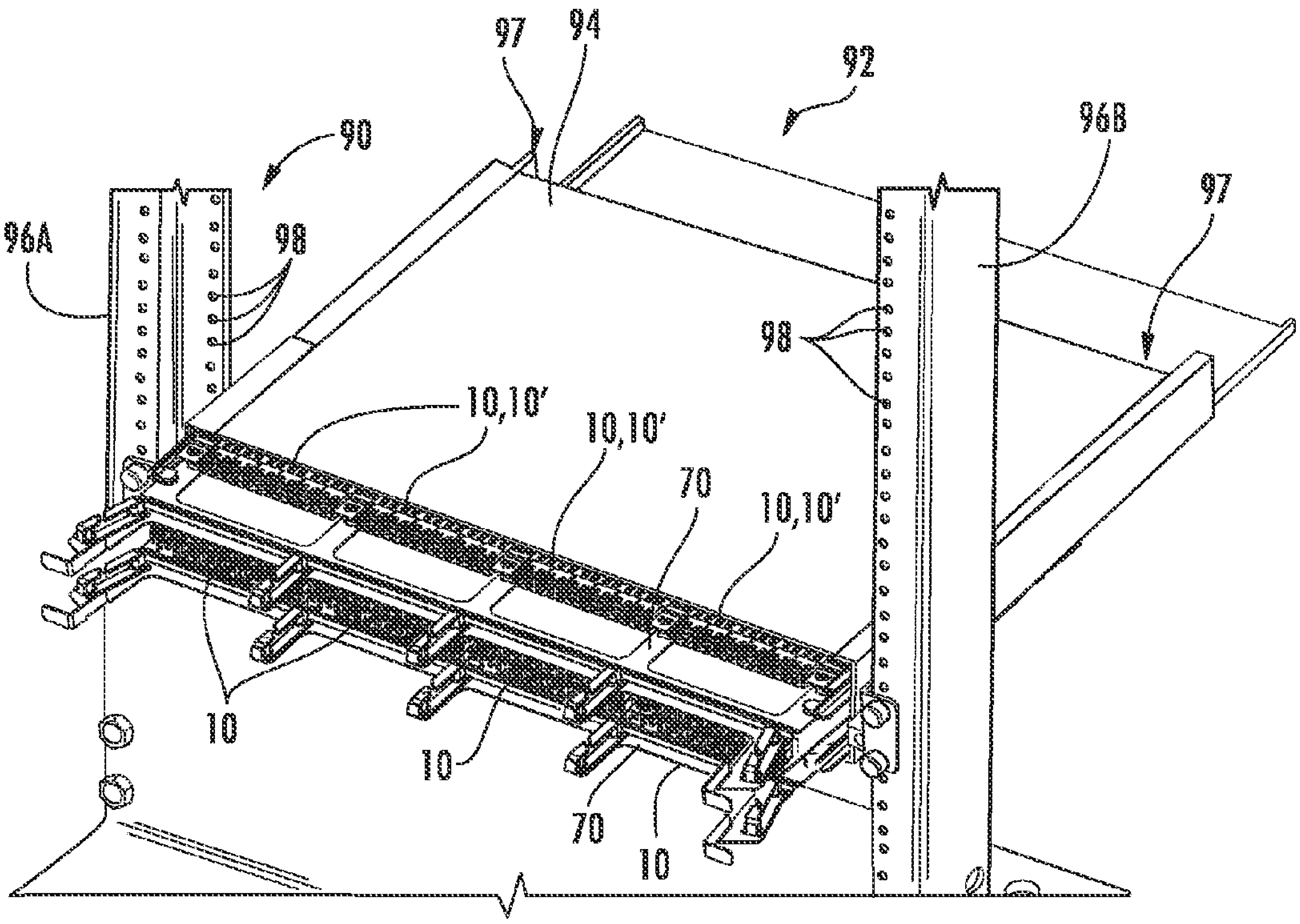

FIG. 11

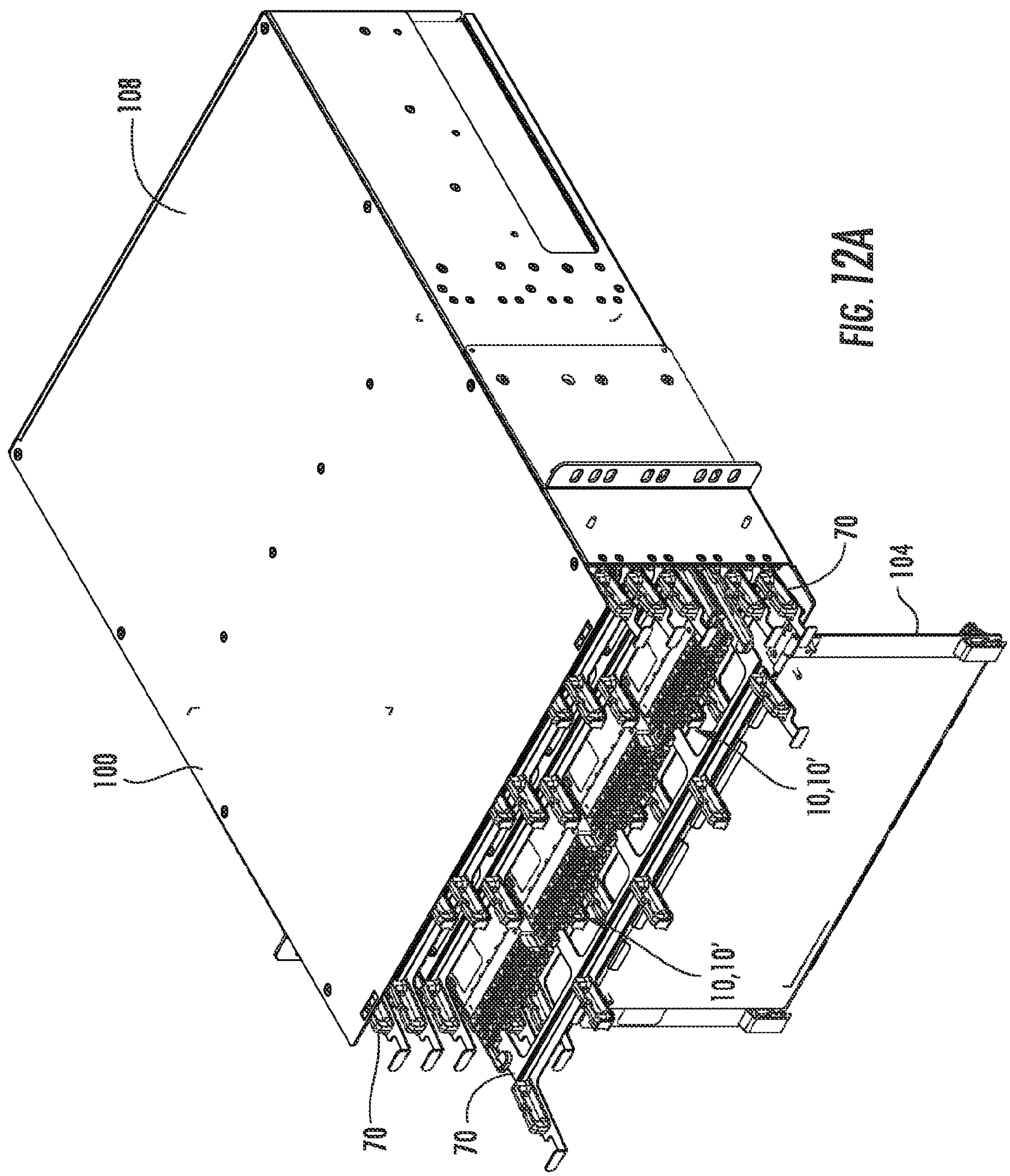

FIG. 12A

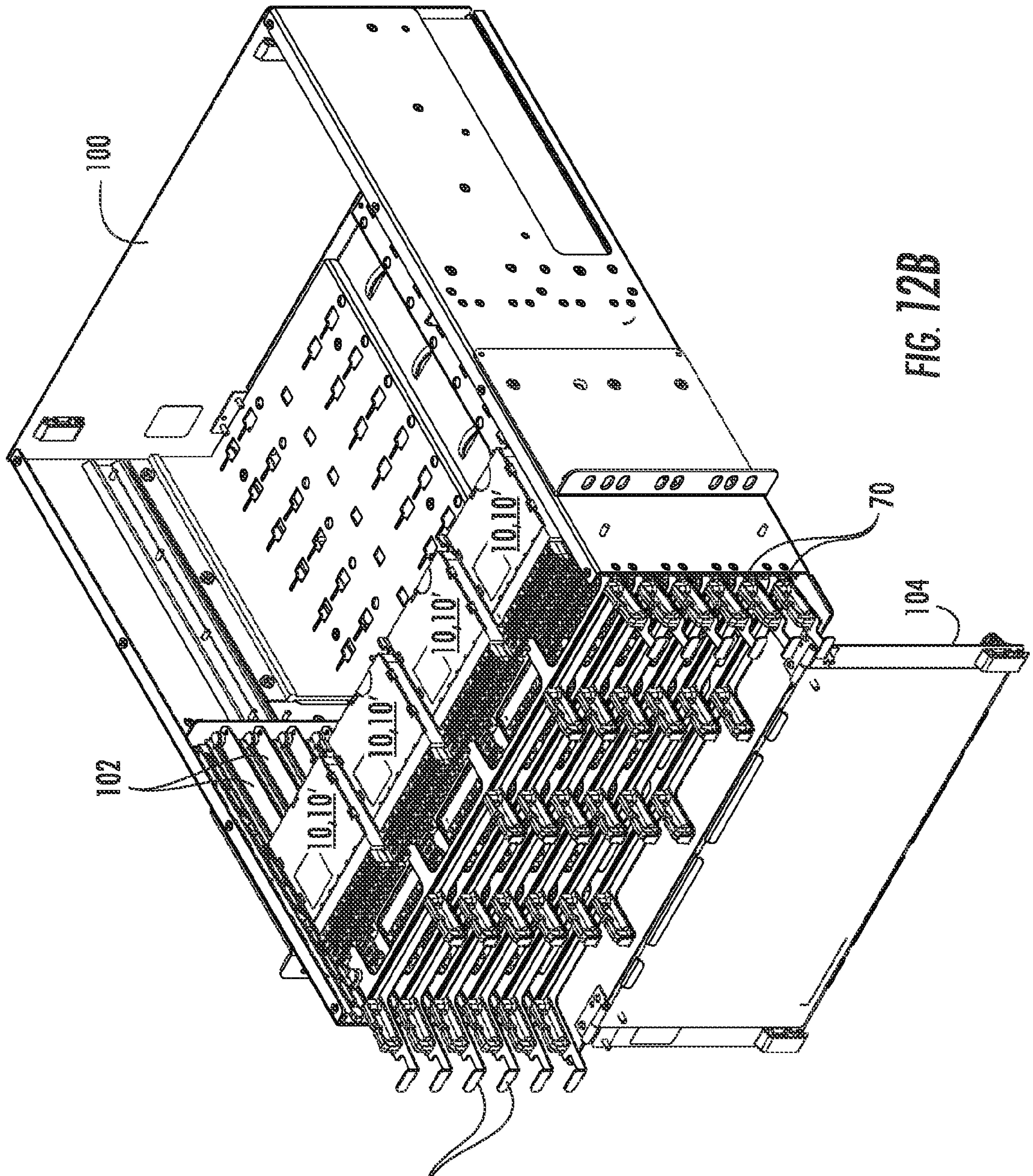

FIG. 12B

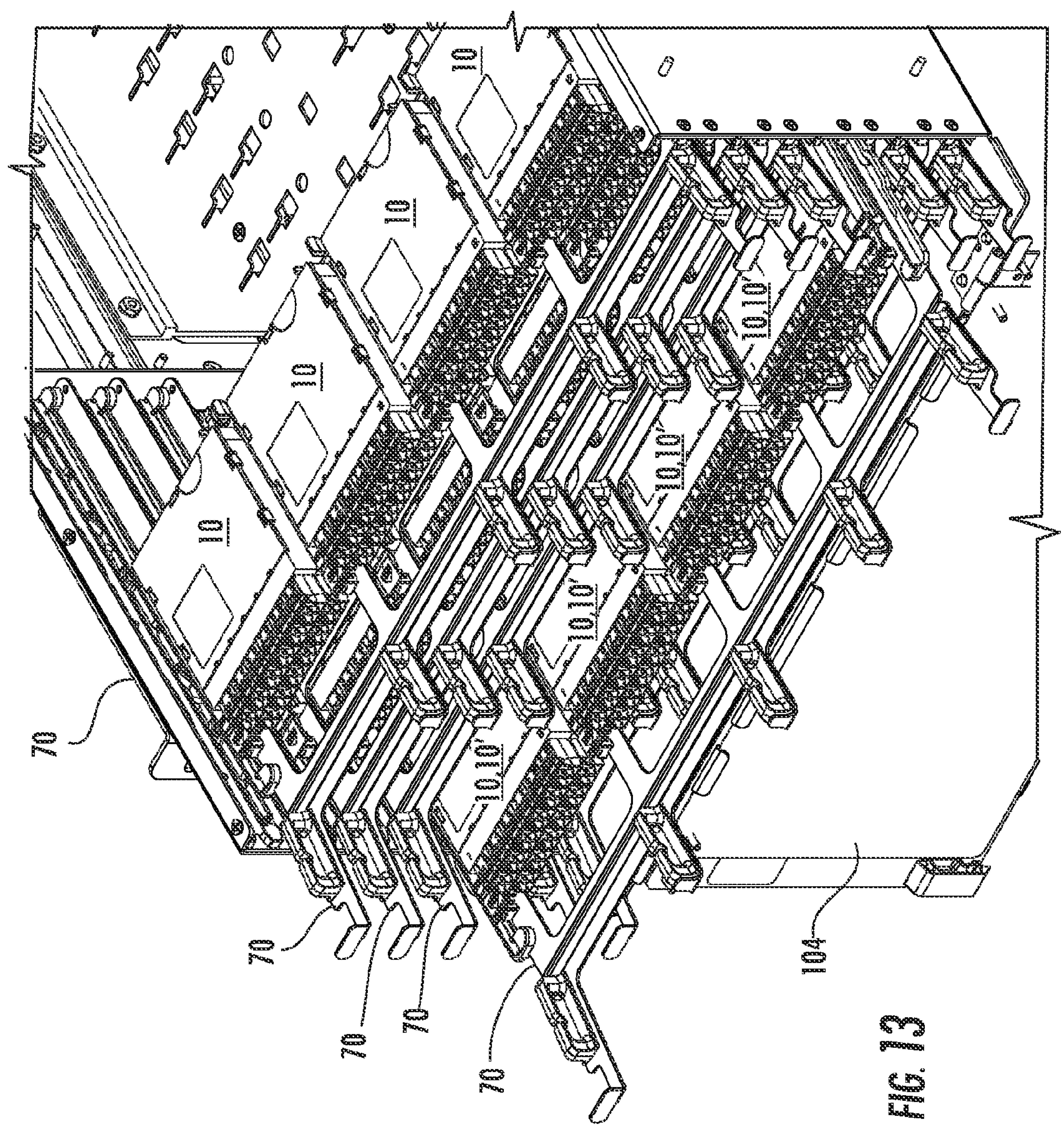

FIG. 13

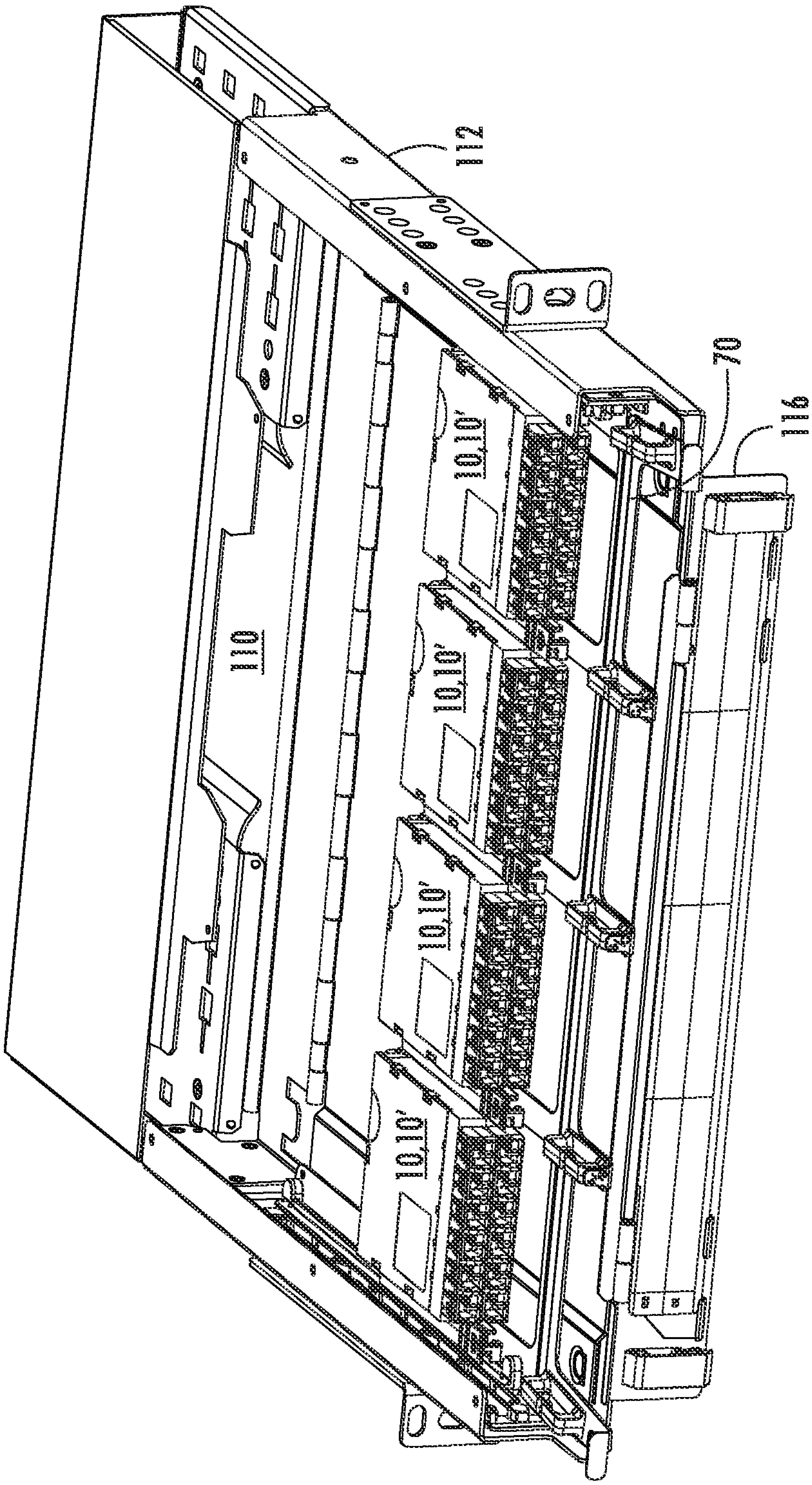

FIG. 14

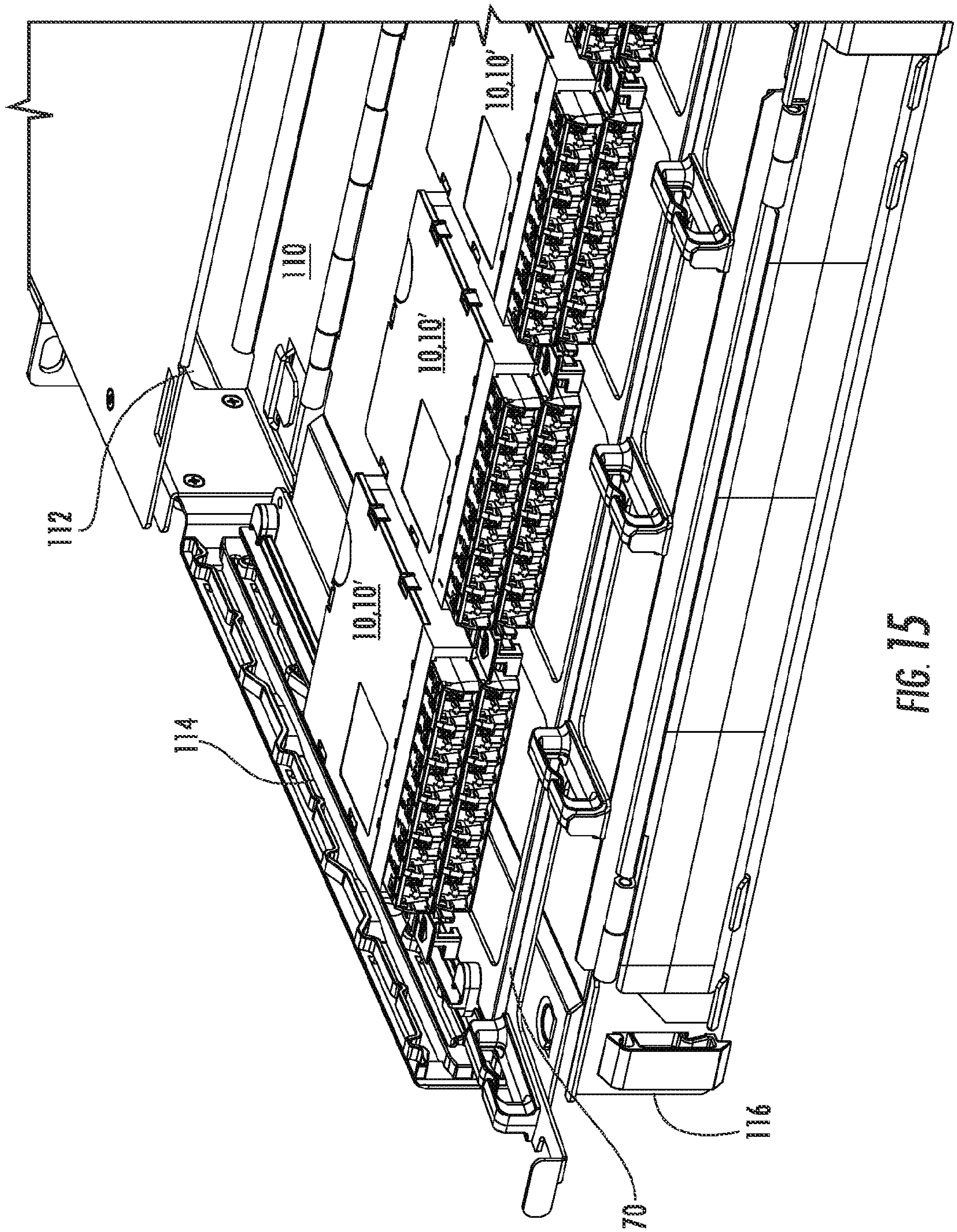

FIG. 15

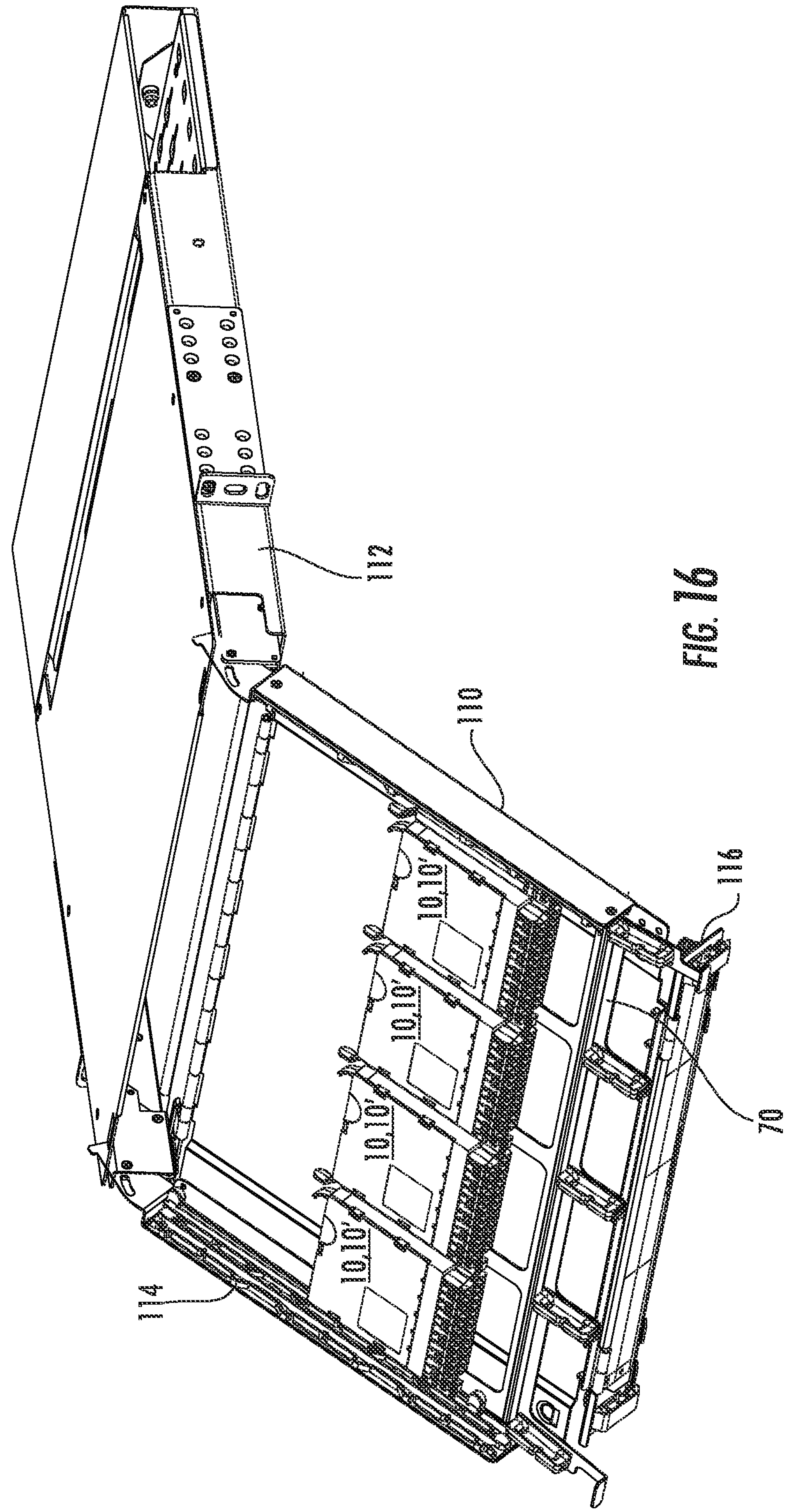

FIG. 16

STACKED FIBER OPTIC MODULES AND FIBER OPTIC EQUIPMENT CONFIGURED TO SUPPORT STACKED FIBER OPTIC MODULES

RELATED APPLICATIONS

The present application claims priority to U.S. Provisional Patent Application Ser. No. 61/408,196 filed Oct. 29, 2010, entitled "Stacked Fiber Optic Modules and Fiber Optic Equipment Configured to Support Stacked Fiber Optic Modules," the disclosure of which is relied upon and incorporated herein by reference in its entirety.

BACKGROUND

1. Field of the Disclosure

The technology of the disclosure relates to fiber optic modules and related fiber optic equipment to support and manage fiber optic connections.

2. Technical Background

Benefits of optical fiber include extremely wide bandwidth and low noise transmission. Because of these advantages, optical fiber is increasingly being used for a variety of applications, including but not limited to broadband voice, video, and data transmission. Fiber optic networks employing optical fiber are being developed and used to deliver voice, video, and data transmissions to subscribers over both private and public networks. These fiber optic networks often include separated connection points linking optical fibers to provide "live fiber" from one connection point to another connection point. In this regard, fiber optic connection equipment, which is also referred to as fiber optic equipment, is located in data distribution centers or central offices to support interconnections.

The fiber optic equipment is customized based on application need. The fiber optic equipment is typically included in housings that are mounted in equipment racks for organizational purposes and to optimize use of space. One example of such fiber optic equipment is a fiber optic module. A fiber optic module is designed to provide cable-to-cable fiber optic connections and manage the polarity of fiber optic cable connections. A fiber optic module is typically mounted to a chassis or housing which is then mounted inside an equipment rack or cabinet. A technician establishes fiber optic connections to the fiber optic modules mounted in the equipment rack. Due to increasing bandwidth needs and the need to provide a larger number of connections in data centers for increased revenue generating opportunities, a need exists to provide fiber optic modules that can facilitate larger numbers of fiber optic connections in a given space.

SUMMARY OF THE DETAILED DESCRIPTION

Embodiments disclosed in the detailed description include stacked fiber optic modules and fiber optic equipment supporting stacked fiber optic modules. In one embodiment, a stacked fiber optic module is provided. This embodiment of the stacked fiber optic module comprises a body having at least one front side and at least one rear side and defining at least one internal chamber disposed between the at least one front side and the at least one rear side. The stacked fiber optic module further comprises a first plurality of fiber optic components disposed in a first longitudinal axis in the at least one front side. The stacked fiber optic module also further comprises a second plurality of fiber optic components disposed adjacent the first plurality of fiber optic components in a second longitudinal axis parallel or substantially parallel to the first longitudinal axis in the at least one front side. Fiber optic equipment supporting stacked fiber optic modules can include, without limitation, fiber optic equipment trays, housings, chassis, and drawers.

Additional features and advantages will be set forth in the detailed description which follows, and in part will be readily apparent to those skilled in the art from that description or recognized by practicing the invention as described herein, including the detailed description that follows, the claims, as well as the appended drawings.

It is to be understood that both the foregoing general description and the following detailed description present embodiments, and are intended to provide an overview or framework for understanding the nature and character of the disclosure. The accompanying drawings are included to provide a further understanding, and are incorporated into and constitute a part of this specification. The drawings illustrate various embodiments, and together with the description serve to explain the principles and operation of the concepts disclosed.

BRIEF DESCRIPTION OF THE FIGURES

FIG. **1** is a front left perspective view of an exemplary stacked fiber optic module;

FIG. **2** is a perspective, exploded view of the exemplary stacked fiber optic module in FIG. **1**;

FIGS. **3**A and **3**B are rear right perspective and side views, respectively, of the exemplary stacked fiber optic module of FIG. **1**;

FIG. **3**C is a rear view of the exemplary stacked fiber optic module of FIG. **1**;

FIG. **4** is a perspective, exploded view of an alternative exemplary stacked fiber optic module having removable and/or sliding sub-bodies;

FIGS. **5**A and **5**B are bottom perspective and front views, respectively, of the top sub-body of the alternative exemplary stacked fiber optic module of FIG. **4**;

FIGS. **6**A and **6**B are side perspective views of the alternative exemplary stacked fiber optic module of FIG. **4** prior to and after the top sub-body being attached to the bottom sub-body, respectively;

FIG. **6**C is a front cross-sectional view the alternative exemplary stacked fiber optic module of FIG. **4** with the top sub-body attached to the bottom sub-body;

FIGS. **7**A-**7**C are front right perspective and side views, respectively, of the exemplary alternative stacked fiber optic module of FIG. **4**;

FIG. **8** is a front perspective view of one fiber optic equipment tray with installed stacked fiber optic modules configured to be installed in a chassis;

FIG. **9** is a front perspective view of the fiber optic equipment tray of FIG. **8** without stacked fiber optic modules installed therein;

FIG. **10** is a close-up view of the fiber optic equipment tray of FIG. **8** with fiber optic modules installed therein;

FIG. **11** is a front perspective view of an exemplary fiber optic equipment rack with an installed exemplary 1-U size chassis supporting fiber optic equipment trays of FIG. **6** each supporting stacked fiber optic modules;

FIGS. **12**A and **12**B are front perspective views of an alternate exemplary 4-U size chassis that can support the fiber optic equipment trays and stacked fiber optic modules according to the fiber optic equipment tray and fiber optic modules disclosed;

FIG. **13** is a front perspective view of the 4-U size chassis of FIGS. **12**A and **12**B with a fiber optic equipment tray supporting stacked fiber optic modules pulled out from the fiber optic equipment tray;

FIG. **14** is a front perspective view of an exemplary fiber optic equipment drawer installed in a chassis and supporting fiber optic equipment trays supporting stacked fiber optic modules, according to another embodiment;

FIG. **15** is a front perspective view of an exemplary fiber optic equipment tray supported by the fiber optic equipment drawer of FIG. **14** and pulled out from the fiber optic equipment drawer; and

FIG. **16** is a front perspective view of the fiber optic equipment drawer of FIG. **14** fully pulled out from the chassis and tilted downward.

DETAILED DESCRIPTION OF THE EMBODIMENTS

Reference will now be made in detail to certain embodiments, examples of which are illustrated in the accompanying drawings, in which some, but not all features are shown. Indeed, embodiments disclosed herein may be embodied in many different forms and should not be construed as limited to the embodiments set forth herein; rather, these embodiments are provided so that this disclosure will satisfy applicable legal requirements. Whenever possible, like reference numbers will be used to refer to like components or parts.

Embodiments disclosed in the detailed description include stacked fiber optic modules and fiber optic equipment supporting stacked fiber optic modules. In one embodiment, a stacked fiber optic module is provided. This embodiment of the stacked fiber optic module comprises a body having at least one front side and at least one rear side and defining at least one internal chamber disposed between the at least one front side and the at least one rear side. The stacked fiber optic module further comprises a first plurality of fiber optic components disposed in a first longitudinal axis in the at least one front side. The stacked fiber optic module also further comprises a second plurality of fiber optic components disposed adjacent the first plurality of fiber optic components in a second longitudinal axis parallel or substantially parallel to the first longitudinal axis in the at least one front side. Fiber optic equipment supporting stacked fiber optic modules can include, without limitation, fiber optic equipment trays, housings, chassis, and drawers.

In this regard, FIG. **1** is a front left perspective view of an exemplary stacked fiber optic module **10**. FIG. **2** illustrates a perspective, exploded view of the stacked fiber optic module **10** in FIG. **1**. As illustrated in FIGS. **1** and **2**, the stacked fiber optic module **10** is comprised of a body **12** receiving a cover **14**. The body **12** has a front side **16** and a rear side **18** and defines an internal chamber **20** (FIG. **2**) disposed between the front side **16** and rear side **18**. The internal chamber **20** is configured to receive or retain optical fibers or a fiber optic cable harness **22** (FIG. **2**) for establishing connections and maintaining desired polarity for first and second pluralities of fiber optic components **24**, **26**. The first plurality of fiber optic components **24** is disposed in a first longitudinal axis A_1 in the front side **16** of the body **12**. The second plurality of fiber optic components **26** is disposed adjacent the first plurality of fiber optic components **24** in a second longitudinal axis A_2 parallel or substantially parallel to the first longitudinal axis A_1 in the front side **16**. In this manner, the stacked fiber optic module **10** is configured to support a great number and/or density of fiber optic components in a given body **12** size or space. The stacked fiber optic module **10** may be employed in high-density fiber optic connection applications.

In this example, the first and second pluralities of fiber optic components **24**, **26** are duplex LC fiber optic adapters that are configured to receive and support connections with duplex LC fiber optic connectors. However, any fiber optic connection type desired can be provided in the fiber optic module **10**. As illustrated in FIG. **3**A, the first and second pluralities of fiber optic components **24**, **26** are connected to a fiber optic component **28** disposed through the rear side **18** of the body **12**. In this manner, a connection to the first and second pluralities of fiber optic components **24**, **26** creates a fiber optic connection to the fiber optic component **28**. In this example, the fiber optic component **28** is a multi-fiber MPO fiber optic adapter equipped to establish connections to multiple optical fibers (e.g., either twelve (12) or twenty-four (24) optical fibers). For example, if the first and second pluralities of fiber optic components **24**, **26** provide twenty-four (24) connections, the fiber optic component **28** may be a twenty-four (24) optical fiber MPO fiber optic adapter to support the connections being provided to a fiber optic cable connected to the MPO fiber optic adapter.

In this example as illustrated in FIGS. **1** and **2**, to provide for both the first and second pluralities of fiber optic components **24**, **26** to be supported by the stacked fiber optic module **10**, the body **12** is comprised of two sub-bodies. A first or bottom sub-body **30** supports the first plurality of fiber optic components **24**, and a second or top sub-body **32** supports the second plurality of fiber optic components **26**. The second sub-body **32** is disposed or "stacked" on top or adjacent to the first sub-body **30** in this example. The first and second sub-bodies **30**, **32** may be provided as part of a single mold for the body **12**. Alternatively, as will be discussed by example below with regard to FIGS. **4-7**C, the first and second sub-bodies **30**, **32** may be cast from two separate molds, wherein the first and second sub-bodies **30**, **32** are secured to each other either permanently or in a removable manner.

With reference back to FIG. **2**, the stacked fiber optic module **10** provides that the first plurality of fiber optic components **24** is disposed in the first sub-body **30** in a first front opening **34** disposed in the first longitudinal axis A_1 in the front side **16** of the body **12**. Similarly, the second plurality of fiber optic components **26** is disposed in the second sub-body **32** in a second front opening **36** disposed in the second longitudinal axis A_2 in the front side **16** of the body **12**. In this example of the stacked fiber optic module **10**, as illustrated in FIG. **3**B, the first front opening **34** is disposed in the same plane or substantially the same plane as the second front opening **36**. This arrangement provides that the first plurality of fiber optic components **24** is disposed in the same front plane or substantially the same front plane P_1 as the second plurality of fiber optic components **26**. As will be discussed in more detail below, other options are possible wherein a stacked fiber optic module is provided that supports a first plurality of fiber optic components disposed in a different plane from a second plurality of fiber optic components.

With continuing reference to FIG. **2**, in this example of the stacked fiber optic module **10**, the cover **14** is configured to engage with the second sub-body **32**. In this regard, tabs **38** are disposed in the second sub-body **32** and configured to engage with complementary detents **39** disposed on the cover **14** to secure the cover **14** to the second sub-body **32** when engaged thereto.

With continuing reference to FIGS. **1-3**B, module rails **40**A, **40**B are disposed on each side **42**A, **42**B of the stacked fiber optic module **10**. In this example, the module rails **40**A, **40**B are disposed on each side **42**A, **42**B of the first sub-body

30. As will be discussed in more detail below, the module rails **40**A, **40**B are configured to be inserted within the module rail guides (not shown) in the fiber optic equipment to support the stacked fiber optic module **10**. In this manner, when it is desired to install the stacked fiber optic module **10** in the fiber optic equipment, either the front side **14** or the rear side **16** of the stacked fiber optic module **10** can be first inserted into the module rail guides of a fiber optic equipment tray to dispose the module rails **40**A, **40**B in the module rail guides. A latch **44** containing a protrusion **46** is shown as being attached to the module rail **40**A to allow the module rail **40**A to be secured within a module rail guide.

The stacked fiber optic module **10** may also be configured to provide a certain density of fiber optic connections. In this regard, the stacked fiber optic module **10** may be provided of certain dimensions. For example, the stacked fiber optic module **10** may be provided wherein the first plurality of fiber optic components **24** is comprised of at least twelve (12) fiber optic connections disposed in a width W_1 (FIG. **2**) of the first front opening **34** of ninety (90) mm or less. Further, the stacked fiber optic module **10** may be provided wherein the second plurality of fiber optic components **26** is also comprised of at least twelve (12) fiber optic connections disposed in a width W_2 (FIG. **2**) of the second front opening **36** of ninety (90) mm or less. As another example, the first front opening **34** may be configured to support a fiber optic connection density of at least one fiber optic connection per 7.0 mm of width W_1 of the first front opening **34**. Likewise, the second front opening **36** may be configured to support a fiber optic connection density of at least one fiber optic connection per 7.0 mm of width W_2 of the second front opening **36**.

As discussed above, the first sub-body of a stacked fiber optic module may be provided as a separate component from a second sub-body of a stacked fiber optic module. The first sub-body and second sub-body may be configured to be permanently attached or be removeably attached. In this regard, FIGS. **4**-**7**C discussed below provide an alternative exemplary stacked fiber optic module **10'** wherein a first sub-body **30'** is a separate component from the second sub-body **32'** when disassembled and secured to each other when assembled. As will be discussed in more detail below, providing the first sub-body **30'** as a separate component from the second sub-body **32'** allows the first sub-body **30'** to be slid about the second sub-body **32'** to provide improved finger access to the fiber optic components **24**, **26**.

In this regard, FIG. **4** is a perspective, exploded view of the stacked fiber optic module **10'** having the separate first sub-body **30'** and second sub-body **32'**. Other components provided in the stacked fiber optic module **10'** that are common and/or provided in the stacked fiber optic module **10** in FIGS. **1**-**3**C are shown in FIG. **4** with common element numbers and thus will not be described again. As illustrated in FIG. **4**, the first sub-body **30'** includes an internal chamber **50** that is configured to receive the fiber optic component **28** disposed through the rear side **18** of the body **12** and to store a cable harness connecting the fiber optic component **28** to the fiber optic components **24** and/or **26**. A fiber guide **52** is disposed in the first sub-body **30'** inside the internal chamber **50** to guide optical fibers from a cable harness. An internal chamber **54** is also disposed in the second sub-body **32'**. To allow optical fibers from a cable harness connected to the fiber optic component **28** to be internally routed to the fiber optic connectors **24**, **26** in both the first sub-body **30'** and second sub-body **32'**, an opening **56** is disposed in a base **58** of the second sub-body **32'**. The opening **56** connects the internal chambers **50**, **54** when the second sub-body **32'** is installed on the first sub-body **30'**.

Features are also provided in the first sub-body **30'** and the second sub-body **32'** to allow the first sub-body **30'** and the second sub-body **32'** to be easily connected together to form the stacked fiber optic module **10'**. In this regard, as illustrated in FIG. **4** and the bottom and front views of the second sub-body **32'** in FIGS. **5** and **6**, respectively, the second sub-body **32'** contains locking tabs **58**A, **58**B disposed on each side **42**A, **42**B. The locking tabs **58**A, **58**B are configured to engage with rails **60**A, **60**B, respectively, disposed inside the first sub-body **30'**. As illustrated in FIG. **5**B and the side cross-sectional view of the stacked fiber optic module **10'** in FIG. **6**A, the locking tabs **58**A, **58**B contain outwardly flared portions **62**A, **62**B. As illustrated in the side cross-sectional view of the stacked fiber optic module **10'** in FIG. **6**B, the outwardly flared portions **62**A, **62**B of the locking tabs **58**A, **58**B, respectively, are configured to interfere with and be pushed out from the rails **60**A, **60**B when the second sub-body **32'** is alignedly disposed on top of the first sub-body **30'** and the second sub-body **32'** is pushed down on the first sub-body **30'**. The outwardly flared portions **62**A, **62**B of the locking tabs **58**A, **58**B then move inwardly in a locking position when disposed below the rails **60**A, **60**B, as illustrated in the front cross-sectional view of the stacked fiber optic module **10'** in FIG. **6**C.

Providing the rails **60**A, **60**B in the first sub-body **30'** to interlock the second sub-body **32'** to the first sub-body **30'** also allows the second sub-body **32'** to be translated about the first sub-body **30'** for improved access to the fiber optic components **24**, **26**, as illustrated in FIGS. **7**A-**7**C. The locking tabs **58**A, **58**B can translate about the rails **60**A, **60**B to allow the second sub-body **32'** to be translated about the first sub-body **30'** in the depth direction, as illustrated in FIGS. **7**A-**7**C.

In this regard, FIGS. **7**A-**7**C illustrate front right perspective and side views, respectively, of the stacked fiber optic module **10'**. As illustrated in FIG. **7**B, the first plurality of fiber optic components **24** is disposed in a different front plane from the second plurality of fiber optic components **26** when the second sub-body **32'** is translated back about the first sub-body **30'**. In this regard, the first plurality of fiber optic components **24** is disposed in a front plane P_2, which is disposed forward of a front plane P_3 where the second plurality of fiber optic components **26** is disposed. This may improve finger access to the first plurality of fiber optic components **24** by providing the first plurality of fiber optic components **24** in a different front plane from the second plurality of fiber optic components **26**. This is because the first plurality of fiber optic components **24** is disposed forward of the second plurality of fiber optic components **26**, such that the second plurality of fiber optic components **26** does not intrude access to the first plurality of fiber optic components **24**, and vice versa. By way of example, a distance D that front plane P_2 extends beyond front plane P_3 is about 10 millimeters or more or vice versa as discussed below.

FIG. **7**C is a side view of the stacked fiber optic module **10'** where the second sub-body **32'** is disposed forward of the first sub-body **30'**, to provide improved finger access to the second plurality of fiber optic components **26**. As illustrated in FIG. **7**C, the first plurality of fiber optic components **24** is disposed in a different front plane from the second plurality of fiber optic components **26** in the stacked fiber optic module **10'** in FIGS. **7**A and **7**B. The first plurality of fiber optic components **24** is disposed in the front plane P_3, which is disposed behind the front plane P_2 where the second plurality of fiber optic components **26** is disposed. This may improve finger access to the first plurality of fiber optic components **24** and second plurality of fiber optic components **26**. Because the first plurality of fiber optic components **24** is disposed behind the second plurality of fiber optic components **26**, the first plurality of fiber optic components **24** does not intrude access to the second plurality of fiber optic components **26**, and vice versa.

The stacked fiber optic modules **10**, **10'** can be configured to be disposed in a variety of different types of fiber optic equipment. For example, FIG. **8** is a front perspective view of a fiber optic equipment tray **70** supporting installed stacked fiber optic modules **10**, **10'** therein. The module rails **40**A, **40**B (FIGS. **1**-**7**C) of the stacked fiber optic modules **10**, **10'** are inserted in module rail guides **72** disposed in the fiber optic equipment tray **70**. Each module rail guide **72** includes a guide **73** to receive the module rails **40**A, **40**B, as illustrated in the unloaded fiber optic equipment tray **70** in FIG. **10**. Note that any number of module rail guides **72** can be provided. The stacked fiber optic modules **10**, **10'** can be installed from both a front end **74** and a rear end **74** of the fiber optic equipment tray **70** in this embodiment. The stacked fiber optic modules **10**, **10'** can then be pushed within the module rail guides **72**.

The stacked fiber optic modules **10**, **10'** can be moved towards the front end **74** until the stacked fiber optic modules **10**, **10'** reach a locking feature **78** disposed in the front end **34**, as illustrated in the close-up view of the fiber optic equipment tray **70** in FIG. **10**. The locking features **78** each include a stop **80**. The stop **80** prevents the stacked fiber optic modules **10**, **10'** from extending beyond the front end **74**. When it is desired to remove a stacked fiber optic module **10**, **10'** from the fiber optic equipment tray **70**, the locking feature **78** can be engaged wherein the stop **80** will move downward away from the stacked fiber optic module **10**, **10'** such that the stacked fiber optic module **10**, **10'** is not obstructed from being pulled forward. The stacked fiber optic module **10**, **10'**, and in particular its module rails **40**A, **40**B (FIGS. **1**-**7**C), can be pulled forward along the module rail guides **72** to remove the stacked fiber optic module **10**, **10'** from the fiber optic equipment tray **70**.

The stacked fiber optic module **10**, **10'** can also be removed from the rear end **76** of the fiber optic equipment tray **70**. To remove the stacked fiber optic module **10**, **10'** from the rear end **76** of the fiber optic equipment tray **70**, the protrusion **46** disposed in the module rails **40**A, **40**B is disengaged by pushing the latch **44** (FIGS. **1**-**7**C) inward towards the stacked fiber optic module **10**, **10'** to release the protrusion **46** from the module rail guide **72**.

With continuing reference to FIGS. **8**-**10**, the fiber optic equipment tray **70** may also contain extension members **82**. Routing guides **84** may be conveniently disposed on the extension members **82** to provide routing for optical fibers or fiber optic cables connected to the first and second pluralities of fiber optic components **24**, **26** disposed in the stacked fiber optic modules **10**, **10'** (FIG. **10**). The routing guides **84** on the ends of the fiber optic equipment tray **70** may be angled with respect to the module rail guides **72** to route optical fibers or fiber optic cables at an angle to the sides of the fiber optic equipment tray **70**. Pull tabs **86** may also be connected to the extension members **82** to provide a means to allow tray guide rails **88** (FIG. **9**) disposed in the fiber optic equipment tray **70** to be easily pulled out from a chassis, as will be described in more detail below.

The fiber optic equipment trays **70** in FIGS. **8**-**10** that support one or more of the stacked fiber optic modules **10**, **10'** are configured to be installed in a chassis or other fiber optic equipment. In this regard, FIG. **11** is a front perspective view of an exemplary fiber optic equipment rack **90** with an installed exemplary 1-U size chassis supporting the fiber optic equipment trays **70** of FIGS. **8**-**10** each supporting stacked fiber optic modules **10**, **10'**.

In this regard, FIG. **11** illustrates exemplary 1-U or 1-RU size fiber optic equipment **92** from a front perspective view. The fiber optic equipment **92** may be provided at a data distribution center or central office to support cable-to-cable fiber optic connections and to manage a plurality of fiber optic cable connections. As shown in FIG. **11**, the fiber optic equipment **92** supports one or more of the fiber optic equipment trays **70** that each support one or more of stacked fiber optic modules **10**, **10'**. In addition, the fiber optic equipment **92** could also be adapted to support one or more fiber optic patch panels or other fiber optic equipment that supports fiber optic components and connectivity.

With continuing reference to FIG. **11**, the fiber optic equipment **92** includes a fiber optic equipment chassis **94** (also referred to herein a "chassis **94**"). The chassis **94** is shown as being installed in the fiber optic equipment rack **90**. The fiber optic equipment rack **90** contains two vertical rails **96**A, **96**B that extend vertically and include a series of apertures **98** for facilitating attachment of the chassis **94** inside the fiber optic equipment rack **90**. The chassis **94** is attached and supported by the fiber optic equipment rack **90** in the form of shelves that are stacked on top of each other within the vertical rails **96**A, **96**B. The tray guide rails **88** of the fiber optic equipment trays **70** previously described with regard to FIGS. **8**-**10** can be inserted into tray rail guides **97** disposed in the chassis **94** to allow each fiber optic equipment tray **70** to be independently extended out from and retracted back into the chassis **94**. As illustrated, the chassis **94** is attached to the vertical rails **96**A, **96**B. The fiber optic equipment rack **90** may support 1-U or 1-RU-sized shelves, with "U" or "RU" equal to a standard 1.75 inches in height and nineteen (19) inches in width. In certain applications, the width of "U" may be twenty-three (23) inches. In this embodiment, the chassis **94** is 1-U in size; however, the chassis **94** could be provided in a size greater than 1-U as well.

Up to three (3) fiber optic equipment trays **70** can be supported by the chassis **94**. However, only one of the fiber optic equipment trays **70** provided in the chassis **94** can support stacked fiber optic modules **10**, **10'** due to the additional space consumed by the stacked fiber optic modules **10**, **10'**. In this regard, two (2) of such fiber optic equipment trays **70** can be provided in the chassis **94** if stacked fiber optic modules **10**, **10'** are included. In this scenario, one fiber optic equipment tray **70** supported in the chassis **94** could contain stacked fiber optic modules **10**, **10'**, and the second fiber optic equipment tray **70** could support non-stacked fiber optic modules **10**, **10'** that have the height of one of the sub-bodies **30**, **32** of the stacked fiber optic module **10**, **10'** (FIGS. **1**-**7**C). The total count of fiber optic connections that can be supported by the chassis **94** is not reduced in any of these configurations.

Chassis sizes other than 1-U are possible. For example, FIGS. **12**A and **12**B are front perspective views of an alternate exemplary 4-U size chassis **100** that can support the fiber optic equipment trays **70** of FIGS. **8**-**10** supporting stacked fiber optic modules **10**, **10'**. The chassis **100** is a 4-U sized chassis and is configured to hold the fiber optic equipment trays **70** each supporting one or more stacked fiber optic modules **10**, **10'**. The tray guide rails **88** of the fiber optic equipment trays **70** previously described with regard to FIGS. **8**-**10** can be inserted into tray rail guides **102** (FIG. **12**B) disposed in the chassis **100** to allow each fiber optic equipment tray **70** to be independently extended out from and retracted back into the chassis **100**, as illustrated in FIG. **13**. A front door **104** is attached to the chassis **100** and is configured to close about the chassis **100** to secure the fiber optic equipment trays **70** disposed in the chassis **100**. A cover **108** is also attached to the chassis **100**, as illustrated in FIG. **12**A, to secure the fiber optic equipment trays **70**. FIG. **12**B illustrates the chassis **100** with the cover **108** removed.

Up to twelve (12) fiber optic equipment trays **70** can be supported by the chassis **100**. However, if the fiber optic equipment trays **70** support stacked fiber optic modules **10**, **10'**, due to the additional space consumed by the stacked fiber optic modules **10**, **10'**, six (6) of such fiber optic equipment trays **70** can be provided in the chassis **100** if all six (6) such fiber optic equipment trays **70** support stacked fiber optic modules **10**, **10'**. Each fiber optic equipment tray **70** disposed in the chassis **100** that includes at least one stacked fiber optic module **10**, **10'** reduces the total number of fiber optic equipment trays **70** that can be supported by the chassis **100** by two (2). However, the total count of fiber optic connections that can be supported by the chassis **100** is not reduced in any of these configurations.

FIG. **14** illustrates alternate exemplary fiber optic equipment that can support the fiber optic equipment trays **70**, which can support the stacked fiber optic modules **10**, **10'**. In this regard, FIG. **14** illustrates a front perspective view of a fiber optic equipment drawer **110** (also referred to herein as "drawer **110**") installed in a chassis **112** and supporting fiber optic equipment trays **70** supporting stacked fiber optic modules **10**, **10'**. FIG. **15** is a close-up view of FIG. **14**.

The chassis **112** includes the drawer **110** supporting one or more extendable fiber optic equipment trays **70**. Each fiber optic equipment tray **70** supported by the drawer **110** is independently translatable from the drawer **110**, whether or not the drawer **110** is extended out from the chassis **112** or tilted downward, as illustrated in FIG. **16**. The fiber optic equipment trays **70** can be moved and extended from the drawer **110** and refracted back into the drawer **110**. Any number of fiber optic equipment trays **70** can be provided. Each fiber optic equipment tray **70** supports one or more of the stacked fiber optic modules **10**, **10'**. The drawer **110** is extendable out from the chassis **112** to allow improved access to the fiber optic equipment trays **70** and the stacked fiber optic modules **10**, **10'** supported therein.

The chassis **112** is a 1-U sized chassis and is configured to hold the fiber optic equipment trays **70** each supporting one or more stacked fiber optic modules **10**, **10'**. The tray guide rails **88** of the fiber optic equipment trays **70** previously described with regard to FIGS. **8**-**10** can be inserted into tray rail guides **114** disposed in the drawer **110**, as illustrated in FIGS. **15** and **16**, to allow each fiber optic equipment tray **70** to be independently extended out from and retracted back into the drawer **110**. A front door **116** is attached to the drawer **110** and is configured to close about the drawer **110** to secure the fiber optic equipment trays **70** and fiber optic modules disposed therein in the drawer **110**.

In the example of the drawer **110** in FIG. **14**, one (**1**) fiber optic equipment tray **70** is supported. This is because although the drawer **110** can support up to two (2) fiber optic equipment trays **70**, the stacked fiber optic modules **10**, **10'** consume space needed for a second fiber optic equipment tray **70**. If only non-stacked fiber optic modules were supported, two (2) fiber optic equipment trays **70** could be supported in the chassis **112**. The number of fiber optic connections supported by the drawer **110**, however, is not reduced.

Many modifications and other embodiments of the invention set forth herein will come to mind to one skilled in the art to which the invention pertains having the benefit of the teachings presented in the foregoing descriptions and the associated drawings. These modifications include, but are not limited to, the number and type of fiber optic components provided in the stacked fiber optic module, the configuration and/or alignment of bodies or sub-bodies of the stacked fiber optic module, the number or type of fiber optic equipment, the number and type of fiber optic module, the number and type of fiber optic equipment tray, and features included in the fiber optic equipment tray. Any size equipment, including but not limited to 1-U, 2-U and 4-U sizes, may include some or all of the aforementioned features and fiber optic modules disclosed herein and some or all of their features. Further, the modifications are not limited to the type of fiber optic equipment tray or the means or device to support fiber optic modules installed in the fiber optic equipment trays. The fiber optic modules can include any fiber optic connection type, including but not limited to fiber optic connectors and adapters, and number of fiber optic connections, density, etc.

Further, as used herein, it is intended that terms "fiber optic cables" and/or "optical fibers" include all types of single mode and multi-mode light waveguides, including one or more optical fibers that may be upcoated, colored, buffered, ribbonized and/or have other organizing or protective structure in a cable such as one or more tubes, strength members, jackets or the like. Likewise, other types of suitable optical fibers include bend-insensitive optical fibers, or any other expedient of a medium for transmitting light signals. An example of a bend-insensitive, or bend resistant, optical fiber is ClearCurve® Multimode fiber commercially available from Corning Incorporated. Suitable fibers of this type are disclosed, for example, in U.S. Patent Application Publication Nos. 2008/0166094 and 2009/0169163.

Therefore, it is to be understood that the embodiments are not to be limited to the specific embodiments disclosed and that modifications and other embodiments are intended to be included within the scope of the appended claims. It is intended that the embodiments cover the modifications and variations of this invention provided they come within the scope of the appended claims and their equivalents. Although specific terms are employed herein, they are used in a generic and descriptive sense only and not for purposes of limitation.

What is claimed is:

1. A stacked fiber optic module, comprising: a body having at least one front side and at least one rear side and defining at least one internal chamber disposed between the at least one front side and the at least one rear side, the body further comprised of a second sub-body engaged on top of a first sub-body to secure the second sub-body to the first sub-body, wherein the second sub-body can translate relative to the first sub-body; a first plurality of fiber optic components disposed in a first longitudinal axis in the at least one front side of the first sub-body; and a second plurality of fiber optic components disposed adjacent the first plurality of fiber optic components in a second longitudinal axis parallel or substantially parallel to the first longitudinal axis in the at least one front side of the second sub-body wherein the first plurality of fiber optic components is comprised of at least twelve (12) fiber optic connections disposed in a width of the first front opening of ninety (90) mm or less; and the second plurality of fiber optic components is comprised of at least (12) fiber optic connections disposed in a width of the second front opening of ninety (90) mm or less.

2. The stacked fiber optic module of claim **1**, wherein the front side of the second sub-body can translate a distance of about 10 millimeters beyond the front side of the first sub-body or vice versa.

3. The stacked fiber optic module of claim **1**, wherein the first plurality of fiber optic components is configured to be disposed in a different plane as the second plurality of fiber optic components.

4. The stacked fiber optic module of claim **1**, wherein the first plurality of fiber optic components are disposed in a first front opening disposed along the first longitudinal axis in the at least one front side of the body.

5. The stacked fiber optic module of claim **4**, wherein the second plurality of fiber optic components are disposed in a second front opening disposed along the second longitudinal axis in the at least one front side of the body.

6. The stacked fiber optic module of claim **5**, wherein the first front opening is configured to be disposed in a same plane or substantially the same plane as the second front opening.

7. The stacked fiber optic module of claim **1**, wherein the first sub-body and the second sub-body are provided as separated bodies.

8. The stacked fiber optic module of claim **1**, further comprising at least one locking tab disposed in the second sub-body configured to engage with at least one rail disposed in the first sub-body to secure the second sub-body to the first sub-body.

9. The stacked fiber optic module of claim **8**, wherein the at least one locking tab is configured to translate about the at least one rail to allow the second sub-body to translate about the first sub-body.

10. The stacked fiber optic module of claim **1**, further comprising at least one rail disposed on either the first sub-body or the second sub-body, and configured to be received within at least one guide member.

11. The stacked fiber optic module of claim **1**, further comprising a cover disposed in either the first sub-body or the second sub-body.

12. The stacked fiber optic module of claim **1**, further comprising at least one fiber optic component disposed through the at least one rear side of the body optically connected to at least one fiber optic component in at least one of the first plurality of fiber optic components and the second plurality of fiber optic components.

13. The stacked fiber optic module of claim **1**, wherein the first plurality of fiber optic components is comprised of a first plurality of fiber optic connectors or a first plurality of fiber optic adapters, and the second plurality of fiber optic components is comprised of a second plurality of fiber optic connectors or a second plurality of fiber optic adapters.

14. The stacked fiber optic module of claim **1**, further comprising at least one rail disposed on the body configured to be received within at least one guide member.

15. The stacked fiber optic module of claim **14**, further comprising at least one latch attached to the at least one rail and configured to engage the at least one rail.

16. The stacked fiber optic module of claim **1** disposed in fiber optic equipment comprised from the group consisting of a fiber optic chassis and a fiber optic equipment drawer.

17. The stacked fiber optic module of claim **5**, wherein:

the first front opening is configured to support a fiber optic connection density of at least one fiber optic connection per 7.0 mm of width of the first front opening; and

the second front opening is configured to support a fiber optic connection density of at least one fiber optic connection per 7.0 mm of width of the second front opening.

18. The stacked fiber optic module of claim **1**, further comprising at least one plurality of optical fibers disposed in the at least one internal chamber;

the at least one plurality of optical fibers optically connected to at least one of the first plurality of fiber optic components and the second plurality of fiber optic components.

19. The stacked fiber optic module of claim **18**, wherein the at least one plurality of optical fibers are provided in at least one fiber optic harness disposed in the at least one internal chamber.

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